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CEYLON.

SESSIONAL PAPER XXII.—1935.

The Ceylon Malaria Epidemic, 1934-35.

Report by the Director of Medical and Sanitary Services.

SEPTEMBER, 1935.

Printed on the Orders of Government.

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Office of the Director of Medical and
Sanitary Services,
Colombo, 21st August, 1935.

SIR,

IN accordance with the request made by the Executive Committee of Health on the 10th January, I have the honour to submit herewith an account of the malaria epidemic which started towards the end of the year 1934.

I have the honour to be,
Sir,
Your obedient servant,

R. BRIERCLIFFE,
Director of Medical and Sanitary Services.

The Honourable
The Minister for Health.

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REPORT ON THE CEYLON MALARIA EPIDEMIC, 1934-35.

SECTION I.

INTRODUCTION.

Few epidemics of malaria have received such universal attention as that which started in Ceylon towards the end of 1934. An official account of it is necessary for several reasons. In the first place it will be required for the future study of epidemic malaria in Ceylon. Although severe epidemics of the disease have occurred in the past (Section VI) and are likely to recur, almost all scientific investigation and study hitherto undertaken have been devoted to endemic malaria, and the special efforts of malaria control which Government has made during the last twenty-five years have all been focussed on centres of high endemicity, so that epidemic malaria has as yet received little attention. Secondly, in February, 1935, it became clear to Government that an epidemic of the magnitude and severity of the one then occurring would have prolonged and far reaching effects on the welfare of the country and that expert advice should be obtained so that a malaria policy for the future might be formulated. Colonel C. A. Gill, I.M.S., was, therefore, invited to visit the Island for a period of some months in the capacity of Expert Adviser on Malaria. He arrived in Colombo on 3rd April, and the terms of reference for his report include a review of the epidemic, the consideration of its probable consequences, and the definition of a future policy with regard to malaria in Ceylon. As a basis for his report an account of the events connected with the epidemic was required and the present report has been compiled with this need in view. It is chiefly a statement of facts and figures; discussion has been kept at a minimum, deductions are avoided as far as possible, no opinion as to the future trend of events is given and no recommendations are made, since these are matters which will be dealt with by Colonel Gill. Thirdly, the misleading and inaccurate accounts of the epidemic which have appeared in the lay press of many countries have made an authoritative statement desirable.

The report is largely compiled from information supplied by officers of the Department of Medical and Sanitary Services and by a few other officers of the Ceylon Government and the names of those who have contributed appear in Appendix 1.

The account of the epidemic given in this report is not complete since it deals with events only to the end of April, 1935. During April and May there swept over the epidemic area a secondary wave of malaria which it is proposed to describe in a future Sessional Paper, and further papers may be necessary during the next few years to deal with the subsidence and end-results of the epidemic.

It is hoped that this account of the malaria epidemic in Ceylon may be not only of local value but of interest to malariologists and medical officers working in other countries.

SECTION II.

GENERAL ACCOUNT OF MALARIA IN CEYLON.

For a detailed study of malaria in Ceylon reference must be made to the " Report on Malaria and Anopheline Mosquitoes in Ceylon " by H. F. Carter assisted by K. J. Rustomjee and E. T. Saravanamuttu published by the Ceylon Government as Sessional Paper VII.—1927. The following summary is based largely on this work :—

1. **Physiography and Climatic Conditions.**

(*a*) *Physiography.*—The Island of Ceylon lies between 5° 55′ and 9° 50′ north latitude. Its latitude is of interest in view of the rarity of extensive epidemics of malaria so near the equator.

Ceylon is 25,332 square miles in area, its greatest length is 270 miles and its greatest breadth 140 miles. The greater part of the Island is low-lying and flat; the northern and north-central parts form one great plain stretching from sea to sea and further south the maritime districts consist of similar level or undulating stretches, but the south-central part of the Island is occupied by a mass of hills and mountains, some of whose peaks reach a height of 7,000 feet or more.

Carter (1927) states " Ceylon is relatively a well-watered country, with numerous rivers and streams; few of the rivers, however, are large or sufficiently deep to allow of navigation, even by small craft, except in their lower reaches. With one or two exceptions (*e.g.*, the Mahaweli-ganga and the Malwatu-oya) the rivers of the Northern, Eastern, and South-Eastern plains are not of large volume, and during the long dry season are often reduced to puny streams meandering in irregular fashion along the sandy beds. Usually in these districts the tributaries dry up completely or retain water only where deep holes occur; many, in fact, merely serve as outlet channels for the storm water of the monsoon, when for short periods they may become swirling torrents rising many feet with great rapidity and flooding the neighbouring lands. In the western and southern areas, on the other hand, many of the rivers and their tributaries are perennial and maintain a considerable volume of water throughout the year . . . . . . In the montane and sub-montane districts and in the south-western lowlands, rivulets and streams are numerous and afford an abundant and continuous water supply. Elsewhere, in those portions (the northern, eastern and south-eastern plains) of the Island which are subjected to long periods of drought, the water supply is precarious, and in ancient times irrigation was undertaken on a large scale from artificial reservoirs or tanks ".

(*b*) *Climatic Conditions.*—The climate of Ceylon is much like that of other islands situated near the equator. In the low plains temperature and humidity are comparatively uniform, but rainfall varies considerably in different parts of the country.

Temperature.—(Table I.) " Along the coast the annual mean temperature is about 80° F., and a noteworthy feature is the smallness of the variation both between day and night in the same twenty-four hours, and between the different parts of the year. At Kandy, 1,654 feet above sea-level, the mean temperature is 76.7° F., and the formula of 1° drop in temperature for each 300 feet rise in altitude holds fairly well throughout the Island.

At Colombo and Galle the mean monthly temperature in the coldest months (December and January) is less than four degrees below those in the warmest months (April and May), while the mean daily ranges for the year are 11.2° and 9.0° respectively.

At Trincomalee on the other side of the Island conditions are only slightly more varied. The mean monthly temperature in June (85.2° F.) is only seven degrees above that in December (77.8°), while the mean daily range for the year is 10.8° F. In the hills there is of course a great variety of climate, and at Nuwara Eliya, over 6,000 feet above mean sea level, frost is occasionally recorded in the early part of the year." (*Colonial Office List, 1935, page 257.*)

TABLE 1.

Monthly Mean Temperatures during 1934, with the offsets from Average.

Averages are taken up to 1934 Inclusive.

Station.	Years	January.	February.	March.	April.	May.	June.	July.	August	September	October.	November.	December.	Year.
Colombo	7	78.0 — 1.1	78.4 — 0.8	78.8 — 1.9	80.8 — 0.8	82.2 + 0.4	80.4 — 0.8	81.0 + 0.1	81.0 + 0.5	81.2 + 0.3	79.2 — 0.5	78.2 — 0.9	79.1 + 0.3	79.9 — 0.4
Puttalam	7–8	77.3 — 0.4	77.1 — 1.7	79.0 —1.9	82.4 0	83.6 + 0.7	82.7 + 0.1	82.6 + 0.8	82.4 + 0.6	82.7 + 0.9	80.8 + 0.2	78.4 — 0.7	77.0 —0.8	80.5 — 0.2
Mannar	9–10	78.0 — 1.0	79.3 — 0.9	81.4 — 1.1	83.7 — 0.8	85.2 + 0 3	84.2 — 0.4	83.2 — 0.5	82.8 — 0.4	82.8 — 0.6	82.7 + 0.5	79.2 — 1.0	78.6 — 0.4	81.8 — 0.5
Jaffna	6–7	77.4 — 0.1	78.0 — 0.4	81.6 0	85.0 + 0.5	85.1 + 0.7	83.8 + 0.4	82.9 + 0.3	82.1 + 0.1	82.6 + 0.6	81.6 + 0.6	78.5 + 0.5	77.1 — 0.2	81.3 + 0.2
Trincomalee ..	7	76.8 — 0.8	77.8 — 1.4	79.8 — 1.0	83.5 + 0.5	85.6 + 1.2	84.8 — 0.2	85.2 + 0.7	85.9 + 1.9	85.5 + 1.5	81.6 + 0.2	78.7 — 0.3	77.4 — 0.3	81.9 + 0.2
Batticaloa	6–7	76.8 — 0.8	77.2 — 0.9	79.2 — 0.8	81.8 — 0.2	83.0 — 0.4	84.5 — 0.1	83.8 — 0.6	83.6 + 0.4	83.0 + 0.3	80.6 — 0.2	78.6 — 0.6	77.0 — 0.6	80.8 — 0.4
Hambantota ..	5–6	77.8 — 1.0	78.2 — 1.0	78.4 — 1.7	81.6 0	81.6 + 0.4	81.8 + 0.4	82.4 + 0.3	80.1 — 0.7	81.6 + 0.8	79.2 — 1.0	79.4 0	79.2 + 0.7	80.1 — 0.2
Galle	6	78.0 — 0.5	78.4 — 0.9	79.1 — 1.5	80.8 — 0.5	81.4 + 0.5	79.5 — 0.7	80.0 0	80.0 + 0.8	80.5 + 0.9	78.6 — 0.4	78.4 — 0 2	78.6 + 0.2	79.4 — 0.2
Ratnapura.. ..	6–7	79.0 — 1.0	80.6 — 0.8	80.2 — 1.9	81.4 — 0.9	82.4 + 1.0	79.8 — 0.5	80.8 + 0.4	81.2 + 0.7	80.9 + 0.7	79.6 0	79.6 — 0.3	80.2 + 0.2	80.5 — 0.2
Anuradhapura ..	5–6	76.0 + 0.1	76.8 — 1.1	79.8 — 1.2	82.4 — 0.6	83.8 + 1.3	83.1 + 0.6	83.6 + 0.6	84.2 + 1.0	85.2 + 2.6	81.8 + 1.0	77.7 — 0.9	75.2 — 1.2	80.8 + 0.2
Kurunegala ..	5–6	77.2 — 0.8	78.2 — 1.2	79.5 — 2.4	81.6 — 1.2	82.6 + 0.6	80.9 — 0.1	81.2 + 0.4	82.2 + 1.2	83.5 + 2.7	81.4 + 1.3	78.9 — 0.5	77.8 — 0.2	80.4 0
Kandy	6–7	74.0 — 0.7	75.2 — 1.1	75.9 — 1.9	78.1 — 0.5	79.4 + 1.2	77.0 + 0.1	76.8 + 0.2	77.6 + 1.2	78.2 + 1.8	77.0 + 1.0	75.8 + 0.1	75.0 0	76.7 + 0.1
Badulla	7–8	69.3 — 0.7	70.2 — 0.6	71.6 — 1.4	74.4 — 0.6	75.6 + 0.2	75.0 + 0.2	75.2 + 0.4	76.0 + 0.8	75.8 — 1.0	75.0 + 0.9	72.2 — 0.1	69.7 — 0.7	73.3 — 0.1
Diyatalawa ..	7–8	64.5 — 0.2	65.0 — 0.3	66.3 — 1.0	68.8 0	69.6 — 0.4	70.2 — 0.2	70.7 + 0.5	70.3 + 0.5	69.8 + 0.4	68.2 — 0.2	66.5 — 0.5	64.2 — 0.9	67.8 — 0.2
Hakgala	—	59.2	58.9	60.8	64.4	65.4	63.4	63.3	64.0	64.6	63.4	61.2	58.7	62.3
Nuwara Eliya ..	6–7	58.0 + 1.0	56.2 — 0.4	57.2 — 1.1	60.2 0	61.2 — 0.2	60.8 + 0.2	60.6 + 0.5	60.7 + 0.3	61.0 + 0.8	60.1 + 0.2	59.1 — 0.7	58.2 0	59.4 0

Except at altitudes approaching 2,000 feet and over, at no season of the year does the temperature fall so low as to stop Anopheline breeding or to render the transmission of malaria impossible. So far as temperature is concerned the breeding of Anophelines and the transmission of malaria could continue in the low country throughout the whole year. There is thus no spell of cold weather to bring a malaria epidemic to an end.

Humidity.—Everywhere in Ceylon there is always a relatively high degree of humidity since no part of the Island is more than sixty-five miles from the sea. The average percentage humidity varies little from month to month, February and March being the months of lowest humidity in the wet zone and along most of the coast. During the south-west monsoon the relative humidity by day is usually well over 70 per cent. in the wet zone, and at night owing to the fall in the air temperature is about 90 per cent. Even in the dry zones the average percentage humidity in any month rarely falls below 60 per cent., so that the existence of Anopheline mosquitoes and the capacity of the malarial parasite to develop in them are seldom threatened by excessive dryness of the atmosphere.

TABLE 2.

Monthly Means during 1934 of the Relative Humidity obtained from Dry- and Wet-Bulb Readings at 9.30 a.m. and 3.30 p.m. with the offsets from Average.

Averages are taken generally over the standard period 1911-30 except at Hakgala where the site of the station was changed at the end of 1925 and averages are taken over the period 1926-34.

Station.	January. %	February. %	March. %	April. %	May. %	June. %	July. %	August %	September. %	October. %	November %	December %	Year. %
Colombo	75 + 5	70 + 2	74 + 6	77 + 6	78 + 2	82 + 4	78 0	77 + 1	74 — 1	78 + 2	76 0	70 — 2	76 + 2
Puttalam	78 + 4	70 + 3	70 + 2	74 + 2	73 — 1	75 — 1	74 — 2	72 — 2	68 — 6	75 — 1	74 — 3	73 — 3	73 — 1
Mannar	81 + 7	72 + 4	73 + 6	76 + 7	74 + 2	75 + 3	77 + 5	77 + 5	75 + 4	76 + 4	76 — 2	76 — 1	76 + 4
Jaffna	76 + 4	69 + 3	70 + 2	75 + 3	78 0	79 — 1	80 0	83 + 3	81 + 1	81 + 1	76 — 4	72 — 5	77 + 1
Trincomalee	83 + 5	76 + 6	76 + 6	70 + 2	66 + 2	64 + 4	60 + 1	58 — 2	61 — 1	72 + 2	77 — 2	78 — 1	70 + 2
Batticaloa	84 + 5	79 + 7	78 + 4	74 + 3	74 + 7	62 + 2	63 + 3	64 + 2	65 + 1	74 + 4	76 — 1	81 + 3	73 + 3
Hambantota	78 + 2	74 + 2	74 0	72 — 3	79 + 1	72 — 4	70 — 3	76 + 4	72 — 2	80 + 4	72 — 6	71 — 7	74 — 1
Galle	82 + 4	78 + 3	78 + 4	79 + 2	83 + 2	86 + 2	84 0	86 + 2	80 — 2	84 + 2	78 — 2	80 0	82 + 2
Ratnapura	78 + 6	68 + 4	74 + 5	80 + 6	74 — 2	81 + 3	74 — 2	71 — 3	70 — 4	81 + 5	77 + 1	74 — 1	75 + 1
Anuradhapura	85 +10	70 + 4	67 + 5	70 + 7	66 — 1	66 0	61 — 3	58 — 2	54 — 7	68 — 2	72 — 5	76 0	68 + 1
Kurunegala	76 + 8	65 + 7	68 + 8	72 + 6	71 — 1	74 — 2	72 — 2	64 — 8	57 — 13	68 — 5	70 — 5	70 — 2	69 — 1
Kandy	74 + 4	61 + 2	66 + 4	71 + 3	68 — 2	76 0	73 — 3	68 — 6	62 — 10	70 — 4	68 — 8	69 — 5	69 — 2
Badulla	86 + 6	77 + 5	74 + 4	70 0	69 0	68 + 4	56 — 5	52 — 8	52 —11	70 0	78 0	84 + 2	70 0
Diyatalawa	84 + 7	74 +11	72 +10	68 + 1	69 + 3	66 + 6	58 — 2	57 — 1	54 — 8	72 + 2	78 + 2	82 + 2	70 + 3
Hakgala	89 + 4	73 — 1	72 — 2	68 — 8	73 — 7	81 — 1	79 0	73 — 7	68 — 8	82 + 1	84 — 1	— —	— —
Nuwara Eliya	80 +10	70 +12	73 +11	68 0	77 + 1	85 + 1	80 — 4	74 — 8	74 — 7	78 — 1	72 — 7	74 — 2	75 0

The averages are taken from observed values, whether shed or screen. Errors caused by the imperfection of the shed exposures are too small to justify the deletion of shed values as yet.

TABLE 3.

Monthly Means during 1934 of the Relative Humidity obtained from the Minimum Dry- and Wet-Bulb Readings with the offsets from Average.

Averages are taken as in the preceding Table.

Station.	January. %	February. %	March. %	April %	May. %	June. %	July. %	August %	September. %	October. %	November. %	December. %	Year. %
Colombo	88 — 3	90 — 2	93 0	93 + 1	89 0	88 + 1	86 — 1	88 + 1	88 — 1	93 + 1	93 — 0	88 — 4	90 0
Puttalam	93 0	90 — 2	93 + 2	91 + 1	89 + 2	84 0	84 — 1	84 — 2	82 — 4	91 + 1	90 — 2	93 0	89 0
Mannar	90 + 4	86 — 1	88 0	89 + 2	82 — 1	82 0	85 + 2	84 + 1	82 0	84 — 1	86 — 2	86 0	85 0
Jaffna	90 0	88 — 2	86 — 2	82 — 3	83 — 2	80 — 5	87 + 1	87 0	87 + 1	91 + 3	88 — 3	90 0	87 — 1
Trincomalee	88 + 2	86 + 4	88 + 1	86 — 2	84 + 1	80 0	80 + 1	76 — 4	78 — 4	86 — 2	86 — 4	82 — 6	83 — 1
Batticaloa	93 + 3	93 + 4	95 + 4	93 + 3	91 + 6	82 + 3	82 + 4	80 + 1	82 +1	91 + 4	90 — 1	93 + 2	89 + 3
Hambantota	90 0	88 — 1	88 — 2	88 — 2	89 0	86 — 1	86 — 2	88 0	86 — 3	88 — 2	88 — 4	85 — 6	88 — 1
Galle	93 + 1	90 0	90 0	88 — 1	89 + 2	91 + 4	89 + 1	91 + 3	86 — 1	93 + 3	93 + 2	93 + 1	90 + 1
Ratnapura	98 + 3	97 + 3	95 + 1	98 + 3	95 0	95 + 1	93 0	93 0	95 + 1	98 + 3	98 + 3	98 + 3	96 + 2
Anuradhapura	97 + 2	95 + 1	95 + 2	95 + 2	93 + 1	91 + 1	88 — 1	86 — 2	86 — 4	95 + 2	95 0	95 0	93 + 1
Kurunegala	95 + 2	95 + 2	95 + 2	95 + 2	95 + 5	88 — 1	88 0	86 — 2	84 — 5	90 — 2	95 + 1	93 0	92 + 1
Kandy	90 + 1	87 0	87 — 3	92 — 1	90 — 1	87 — 2	87 — 1	85 — 3	85 — 5	90 — 3	92 — 2	87 — 5	88 — 2
Badulla	97 + 2	94 0	97 + 2	97 + 2	95 0	95 + 1	91 — 2	91 — 3	94 0	95 — 1	95 — 1	94 — 2	95 0
Diyatalawa	94 + 3	91 + 6	91 + 5	89 + 1	89 + 5	79 + 1	76 — 1	78 — 1	80 — 2	89 + 1	94 + 4	94 + 2	87 + 2
Hakgala	94 + 2	84 — 3	88 — 1	85 — 6	85 — 4	86 — 2	92 + 5	86 — 2	83 — 2	91 + 3	91 0	— —	— —
Nuwara Eliya	93 + 2	89 + 2	93 + 3	90 — 3	— —	91 0	88 — 3	85 — 7	88 — 4	91 — 2	87 — 6	93 + 1	— —

The minimum dry- and wet-bulb temperatures do not necessarily occur at the same instant and a consequent uncertainty is introduced. The evidence of thermographs shows that the uncertainty is very small, and the publication of this table seems desirable owing to the fact that the relative humidity at night differs considerably from that during the day, and hence Table 2 alone gives a very incomplete statement of conditions as a whole.

Note.—Tables 1, 2 and 3 are taken from the Report of the Superintendent, Colombo Observatory for 1934.

Rainfall.—Ceylon may be divided into a wet zone and dry zones. For the purpose of the present study the wet zone may be defined as the area which receives during the period of the south-west monsoon an average rainfall of twenty inches or more (*Map No. 1*). This zone covers the south-west quadrant of Ceylon—the coastal plain as well as much of the hill country—and in addition to the rains of the south-west monsoon it receives those of the north-east. Over most of this zone the average annual rainfall is more than 100 inches and in places reaches 200 inches.

The dry zones of the northern and south-eastern portions of the Island are affected only slightly by the south-west monsoon and depend for their rain principally on the north-east monsoon. It is on account of the comparative lack of rain during the south-west monsoon and the long period of drought which results that these zones are called dry. Their average rainfall is less than 75 inches a year and there are large tracts with annual averages of less than 40 inches (*Map No. 5*).

The south-west monsoon blows from the end of May to October and the north-east from the end of October or early November to April. Between the end of one monsoon and the break of the next is an inter-monsoonal period during which there is usually heavy rain. This inter-monsoonal rain falls all over Ceylon during October, but is chiefly confined to the wet zone in March and April. Towards the end of each monsoon the rainfall becomes less and the chief rainy seasons are, therefore, April to June and October to January in the wet zone and October to January in the dry zones.

TABLE 4.

Mean Monthly Rainfall, 1911-1930, at Stations in the Wet and Dry Zones.

Wet Zone.

Station.	Height above sea level. Ft.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Colombo	24	4.0	2.2	4.9	8.9	15.0	9.0	6.0	2.6	7.0	13.2	12.3	5.6	90.8
Galle	14	3.6	3.0	6.2	8.8	12.5	8.7	6.7	5.2	10.4	11.6	11.1	8.2	96.0
Kalutara	10	4.6	3.4	7.2	12.6	17.5	9.3	7.9	4.1	9.5	13.1	14.9	7.8	111.8
Kandy	1611	6.7	1.8	5.8	6.2	6.0	9.6	7.6	5.5	6.6	10.9	11.2	9.1	86.9
Kurunegala	381	4.9	1.7	6.0	9.4	6.7	7.4	4.1	2.7	6.2	15.8	13.5	7.1	85.6
Labugama	380	6.9	4.5	10.2	14.1	21.5	19.0	12.3	8.2	16.0	20.3	17.5	12.0	162.6
Nuwara Eliya	6170	6.7	1.7	4.3	4.7	6.9	10.9	11.8	7.7	8.9	10.6	9.5	8.0	91.8
Panilkanda estate, Deniyaya	1900	9.4	5.2	13.3	10.8	11.6	9.4	7.6	4.9	9.4	13.6	15.5	14.7	125.4
Ratnapura	113	6.5	4.4	11.0	11.2	20.1	19.0	13.3	10.6	16.3	17.8	15.0	9.2	154.5
Watawala	3259	5.6	2.9	7.3	11.0	21.9	40.7	29.8	26.7	27.0	24.0	15.1	7.3	219.5

Dry Zone.

Station.	Height above sea level. Ft.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Anuradhapura	295	5.7	1.5	3.6	5.9	3.1	0.9	1.4	1.2	3.9	9.8	11.5	7.6	56.2
Batticaloa	26	13.8	2.7	3.4	1.8	1.9	1.0	1.2	1.8	2.6	7.1	15.9	17.2	70.1
Hambantota	61	3.7	1.0	3.8	3.3	3.4	2.2	2.4	1.0	3.1	4.8	7.8	5.6	42.3
Jaffna	14	4.3	1.2	1.8	1.5	1.6	0.4	0.6	1.0	3.1	9.6	16.3	9.4	50.9
Mannar	12	4.0	1.7	1.7	3.1	1.9	0.5	0.5	0.5	1.3	7.0	9.8	7.8	39.9
Paranthan	25	6.0	1.1	1.2	2.1	2.1	0.6	0.2	0.8	1.6	7.0	17.1	12.0	51.8
Puttalam	27	3.6	1.1	3.3	4.9	3.7	1.7	1.4	0.2	1.8	8.1	10.0	6.2	45.9
Tirukkovil	6	13.8	3.0	4.8	2.4	1.3	1.2	1.0	1.1	2.0	4.8	9.7	13.5	58.7
Trincomalee	99	8.7	2.0	2.4	2.0	3.4	1.1	1.9	3.5	3.8	9.1	14.3	12.6	64.8

2. **The Anopheline carrier and its habits.**

Eighteen species of Anopheline mosquitoes occur in Ceylon. Of these, some are relatively uncommon, of restricted distribution, or of retiring habits and are seldom seen except within their own particular areas or haunts. But in any locality below an elevation of 3,000 feet, some ten or twelve different kinds of Anophelines are present in greater or less abundance depending chiefly on physical, climatic, or local conditions. The best known and most prevalent of these are *A. subpictus*, *A. vagus*, and *A. hyrcanus* which possess a wide range of breeding-habits and are the predominant species in paddy fields; *A. jamesi*, *A. pallidus*, *A. barbirostris*, shade-loving forms which commonly breed in swamps, pools, tanks, and other bodies of water containing much vegetation; *A. varuna*, a river and stream breeding species, but one which also favours wells, irrigation channels and other situations where the water is clear and fresh; *A. maculatus* which does not occur in the plains but becomes increasingly plentiful from the foot-hills upwards, selecting especially clear, sunny streams and channels or seepage water for breeding purposes; and *A. culicifacies*, the chief—and so far as is known at present the only—carrier of malaria in the Island.

A considerable amount of research on the transmission of malaria in Ceylon has been carried out during the past several years by the Medical Entomologist. This work has been done in many different districts, including areas of high malarial endemicity and localities where epidemics were in progress. Many thousands of Anopheline mosquitoes collected from town and village houses, from labourers lines and other places have been examined for malaria parasites, but *A. culicifacies* is the only species which has yet been found infected. And furthermore, in every malaria epidemic which has been investigated—even when these occurred in areas where *A. culicifacies* is not normally prevalent—a close association with this mosquito has been demonstrated. While it is possible that further research may incriminate other indigenous Anophelines, especially *A. maculatus* and *A. varuna*—the former an important carrier in Malaya, the latter one of a group of closely related carrier species common in neighbouring countries—the evidence available indicates strongly that *A. culicifacies* is the most active transmitting agent of the disease in Ceylon. Further details relating to the transmission of malaria by this mosquito during the present epidemic are given on page 23 of this report.

A. culicifacies must, therefore, be regarded as the most important Anopheline mosquito in Ceylon. In areas where it is abundant—whether urban or rural—malaria is invariably prevalent, and in those where normally it merely maintains a precarious existence its appearance in increased numbers is frequently followed by localized epidemics. Fortunately, as already indicated, this mosquito is not distributed uniformly throughout the Island. It is essentially a "dry-zone" species and is normally prevalent throughout the extensive and largely jungle-covered plains of the north, east, and south-east. It extends from the plains, through the foot-hill country, into the hills of the drier districts up to altitudes of 2,000 feet to 2,500 feet, above which it rapidly decreases in prevalence. In the wet-zone—whether the hot, moist districts of the plains and foot-hills or the cooler moist districts of the hills—*A. culicifacies* does not thrive; it occurs erratically and usually in small numbers. And to this fact is largely due the relative freedom from malaria of the prosperous south-western portion of Ceylon (from a little north of Colombo, southwards to Matara and eastwards to the hills). But the mere presence of this mosquito in this area is a constant source of danger, for should conditions arise—climatic, agricultural, or industrial—which unduly favour its increase it will, sooner or later, prove a serious menace to health. In those districts where climatic conditions are more or less intermediate in character between the dry and wet zones, the prevalence of *A. culicifacies* is more variable. In years of normal rainfall it becomes increasingly more numerous towards the drier parts of the intermediate area, but in years of drought it also becomes plentiful in the wetter districts. The largest of these intermediate zones includes an area which is particularly liable to epidemic malaria, and which during the present severe outbreak has suffered intensely. It embraces roughly a belt of country extending from the hills on the east to within a few miles of the coast on the west, and from the Maha-oya or somewhat south of this river, to the vicinity of Kurunegala.

A. culicifacies is a small, inconspicuous mosquito, brown in colour with wings less conspicuously spotted than in many Anophelines. Its resting attitude resembles that of the common *Culex* mosquito the angle formed by its body with the supporting structure being much less obtuse than is usual with *Anopheles*. Although definitely domestic in its habits—in the sense that it commonly invades houses and feeds readily upon man—it is an unobtrusive species, keeping to the shadows and causing little annoyance by its bite. It becomes active towards evening, especially from dusk until 9 P.M. or 10 P.M. and again in the morning a little before dawn, from 5 A.M. to 6 A.M., but individuals may be found biting at all hours of the night. Unlike some Anophelines, it remains in houses after biting, resting for many hours after repletion and secreting itself in dark corners, holes and crevices and other secluded places. Dwellings of primitive construction such as those built entirely of 'cadjan', or of mud and wattle with thatched or 'cadjan' roofs afford innumerable resting and hiding places for this mosquito which often penetrates deeply into the interstices between the leaves or straw. In India, it also feeds freely upon cattle and occurs abundantly in cattle-sheds and out-houses. The evidence in Ceylon upon this point is not conclusive owing mainly to the fact that throughout the greater part of the low-country, cattle are tethered in the open at night and are not brought into enclosed sheds. But traps with animal bait have not attracted large numbers of this species. In Ceylon, too, it is not commonly found in out-houses unless these have been tenanted overnight.

The breeding places of *A. culicifacies* vary considerably in character. They include such different types as slow-moving sandy rivers (*Photographs 1 and 2*) and streams, sand and rock-pools in the beds of rivers, irrigation channels, wells, temporary rain-pools, water in borrow-pits, brick-fields, and quarries, in unbuilt drains, and even in puddles and the hoof-prints of cattle. The most favoured sites—and those where breeding is most prolific—are bodies of clear, fresh water containing little aquatic vegetation and open to the sun. In its younger stages *A. culicifacies* is a sun-loving mosquito, and the larvae often occur in great numbers in shallow sandy or rocky pools in completely exposed situations where the water, during the greater part of the day, is definitely warm. In the rivers and large streams of the dry zones, the volume and velocity of the water is often greatly reduced during the dry period of the year; and from July to September the conditions existing in the beds may be most favourable for the breeding of this mosquito. The shallow unshaded margins of the streams then support large numbers of larvae, and numerous pools of the types mentioned above become exposed. At such times malaria may become prevalent in the vicinity of the rivers, even although elsewhere all or most of the breeding places of *A. culicifacies* have disappeared. This, for example, occurs at Kataragama, the site of the important festival held annually in July or August. The prevalence of malaria among the pilgrims is determined largely, if not entirely, by the state of the river; if the water is flowing at moderate speed and is sufficient to cover the bed, there is little malaria, but if the river is low and pools are present numerous cases occur when the pilgrims return to their homes. Accordingly, for some years past, the river prior to and during the festival has been carefully watched and when necessary control measures have been instituted. In the intermediate zone and northern part of the wet zone the rivers are less frequently liable to assume such conditions as those indicated above, and when they do it generally occurs during the drier months from February to April or August and September. But in years of exceptional drought such as that of 1934-1935 they (and particularly the Maha-oya) may provide most favourable facilities for the breeding of this mosquito over prolonged periods. In the wet zone proper, the rivers and streams almost invariably contain sufficient water to cover the beds and seldom act as breeding places of *A. culicifacies*. Such breeding places as do occur in this area are usually associated with metal quarrying or brick making.

The importance of rivers and streams in the drier parts of Ceylon as breeding places of this malaria-carrying mosquito cannot be over emphasised, but in malaria control work there are many others which must not be neglected. Chief among these—and of much practical importance—are wells, borrow-pits, and quarry-pits. Those of the last two categories are not as a rule difficult to control, but wells in some towns, *e.g.*, Chilaw, Puttalam, Trincomalee, and Kurunegala are the main reservoirs of the mosquito and present great obstacles to the sanitarian.

3. Endemicity.

(*a*) *Distribution and Prevalence of Malaria.*—Malaria is endemic throughout the dry zones of Ceylon. It is highly endemic or hyper-endemic over the whole of the Northern Province (with the exception of the densely populated extremity of the Jaffna Peninsula), the

North-Central Province, the northern two-thirds of the North-Western Province, the Eastern Province, except parts of the coastal fringe, the low-country of the Uva Province and the Hambantota District of the Southern Province.

Over these areas the disease occurs throughout the year, but there is a seasonal increase after the break of the north-east monsoon in October, and the " fever season " extends from the beginning of November to the end of February. In many parts of the dry zone there is also a smaller seasonal increase in May and June.

In the wet zone malaria is very much less prevalent. Along the coast from Negombo to Matara it rarely occurs, but further inland localized outbreaks are by no means uncommon in April, May, and June in the neighbourhood of the rivers, particularly in the region of the foothills where the disease may be considered to be moderately endemic. Quarrying in this area has also been shown to be a not infrequent cause of localized outbreaks (*Carter, 1930*).

The hill country at altitudes above 2,000 feet is mostly free from malaria but patients who have been infected in the deeper valleys are often treated at the hospitals and dispensaries in the hills. In the southern part of the North-Western Province where the rainfall tends to become intermediate between that of the wet and dry zones the degree of endemicity is moderate to high and there are, as a rule, seasonal increases both in May and June and in November and December.

It is the comparatively healthy wet zone of Ceylon which in the past has been subjected to epidemics of malaria similar in many respects to the present epidemic though far less extensive and devastating. (Section VI.)

The spleen rate among children affords perhaps the most accurate guide to endemicity. Carter (1927) mentions the spleen surveys made between 1908 and 1918 but points out various serious errors which render them unreliable. He describes the survey of 1921-22 which is accepted as the most dependable one yet made (*Tables 5 and 6*) as follows:—

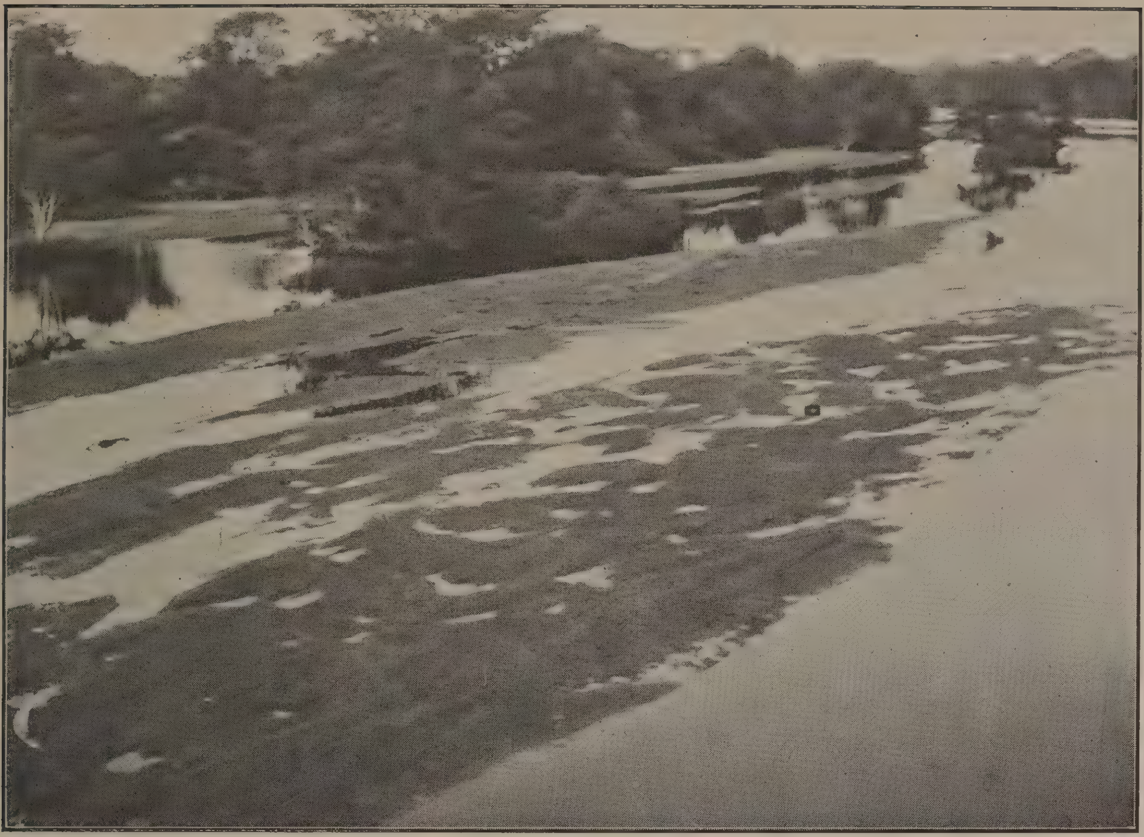
> The work was commenced in July, 1921, and the preliminary survey completed in July, 1922, but in numerous special areas more detailed examinations have since been performed and have provided additional information. Over 500 towns and villages in various parts of the Island have been visited and random samples of the inhabitants examined; in the majority of cases the samples were limited to children, but in the sparsely populated districts male adults were also included. In the hill-country and estate districts the examinations were confined largely to the children of the resident villagers rather than to the children of the estate labourers, since it is obvious that the former would, in general, offer far more reliable data regarding the endemicity of malaria than the latter. In the larger towns and villages the practice was to examine the school children, and if the sample so obtained was not considered representative of all classes of the community, to supplement it by house and street examinations.

TABLE 5.

Endemic Prevalence of Malaria in Ceylon—July, 1921-July, 1922 (Carter, 1927, p. 15).

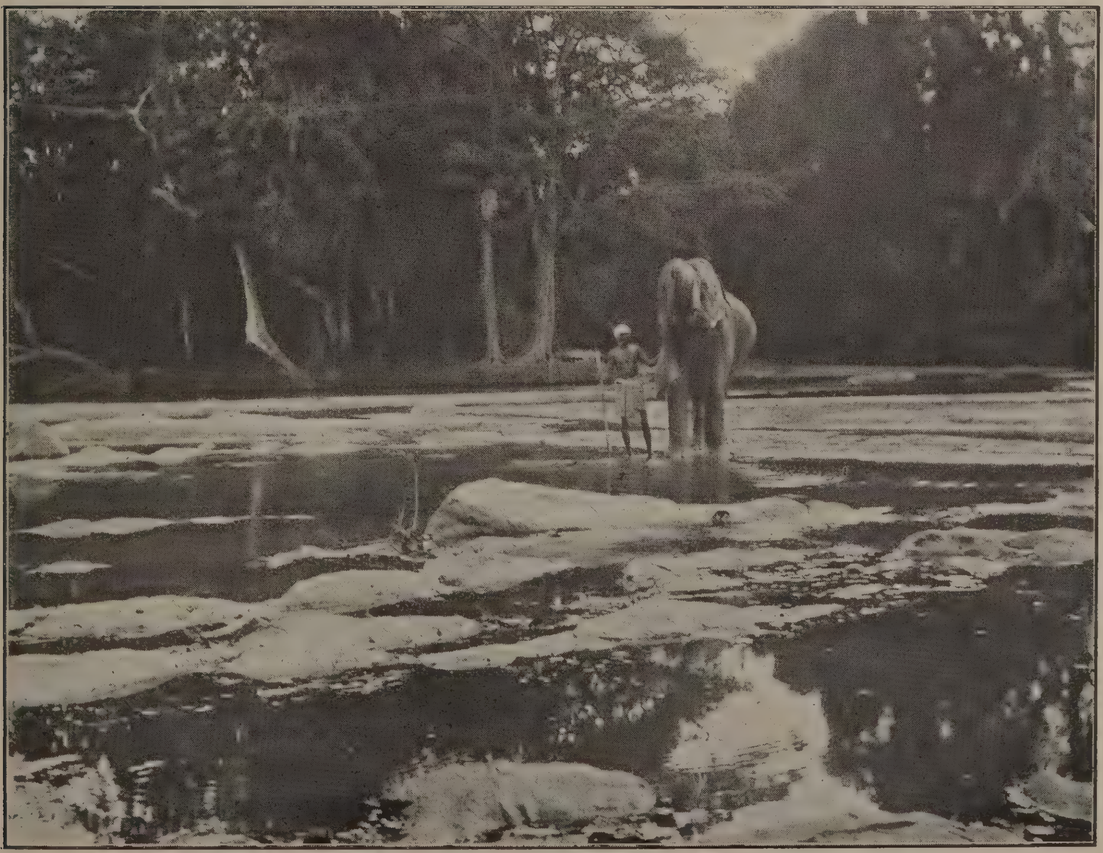
Province.	Spleen.			Blood.		
	Children examined.	Number Positive.	Spleen Rate.	Children examined.	Number Positive.	Parasite Rate.
Western	18,414	254	1.4	1,068	25	2.3
Southern—						
(*a*) Wet Zone (over 75″ rainfall)	5,052	197	3.7	125	1	0.8
(*b*) Dry Zone (less than 75″ rainfall)	1,387	370	26.5	134	14	10.5
Sabaragamuwa	4,437	451	10.2	267	30	11.2
Central—						
(*a*) Below 500 metres	813	152	18.7	144	32	22.2
(*b*) 500–1,000 metres	3,443	242	7.0	154	11	7.1
(*c*) Over 1,000 metres	744	8	1.1	10	—	—
Uva—						
(*a*) Below 500 metres	245	138	56.3	22	4	18.2
(*b*) 500—1,000 metres	1,116	96	8.6	308	43	14.0
(*c*) Over 1,000 metres	448	8	1.8	30	1	3.3
Northern—						
(*a*) North and North-west portions of peninsula	4,176	359	8.6	306	43	14.0
(*b*) Elsewhere	3,232	1,034	32.0	342	59	17.3
North-Central	1,807	955	52.7	601	176	28.8
North-Western	5,785	2,084	36.2	754	114	15.2
Eastern	5,273	1,288	24.4	775	131	16.9
Totals	56,372	7,636	13.6	5,040	684	13.5

Photograph 1.



SAND-POOLS IN BED OF MAHA-OYA FORMING SUITABLE BREEDING PLACES FOR *A. culicifacies* (DECEMBER, 1934).

Photograph 2.



ROCK-POOLS IN MAHA-OYA FORMING SUITABLE BREEDING PLACES FOR *A. culicifacies* (DECEMBER, 1934).

TABLE 6.

Spleen Rates in Principal Towns of Ceylon during 1922-1924 (*Carter, 1927, p. 17*).

Town.	Date.	No. of Children examined.	No. of Children with enlarged Spleen.	Spleen Rate Per cent.
Colombo	March 1923	3,468	24	0.7
Negombo	August 1922	194	0	0.0
Do.	August 1924	402	23	5.7
Panadure	August 1923	122	1	0.8
Kalutara	August 1923	200	2	1.0
Galle	February 1922	231	6	2.6
Matara	February 1922	205	2	1.0
Tangalla	May 1922	92	7	7.6
Do.	November 1924	329	28	8.5
Hambantota	May 1922	92	21	22.8
Do.	November 1924	217	17	7.8
Batticaloa	November 1922	307	63	20.5
Trincomalee	September 1923	1,331	188	14.1
Do.	June 1924	331	151	45.7
Do.	September 1924	594	97	16.4
Mullaittivu	July 1922	162	59	36.4
Do.	February 1924	133	61	45.8
Jaffna	Dec.–Feb. 1923	1,746	229	13.1
Do.	February 1924	1,519	188	12.5
Mannar*	August 1921	152	18	11.8
Do.	September 1924	118	11	9.3
Anuradhapura	March 1922	449	221	49.2
Do.	August 1923	661	332	50.2
Puttalam	April 1923	123	54	43.9
Chilaw	February 1922	119	44	37.0
Do.	February 1923	161	66	41.0
Kurunegala	November 1922	1,087	356	33.6
Kegalla	September 1924	299	51	17.0
Ratnapura	January 1922	74	9	12.2
Do.	September 1924	266	24	9.1
Kandy	September 1924	585	42	7.2
Matale	September 1924	175	25	14.3
Gampola	June 1922	400	11	2.8
Nuwara Eliya	July 1922	42	0	0.0
Do.	July 1924	240	0	0.0
Badulla	November 1922	553	112	20.2

* Schools only examined.

Map No. 2 is a graphic representation of the distribution of malaria in Ceylon as determined by this spleen census. Carter (1927, p. 16) gives the following synopsis of the main zones or areas of malarial prevalence:—

A.—Low-country (0-200 metres).

(1) *Endemicity low. Spleen rates from 0-10 per cent.*—

(*a*) The south-west portion of Ceylon extending from the coast to the sub-montane district of Sabaragamuwa, and including almost the whole of the Western Province and the western half of the Southern Province.

(*b*) The north and north-west portions of the Jaffna peninsula.

(2) *Endemicity moderate to high. Spleen rates from 10-40 per cent.*—

(*a*) Two areas adjourning the south-west quadrant—

(1) (*a*) on the north and south-east respectively; the former including the northern limits of the Western and Sabaragamuwa Provinces, and the southern portion (as far north as Kurunegala) of the North-Western Province, the latter a small portion of the Southern Province (Hakmana, Beliatta, &c.).

(*b*) The eastern littoral extending from Trincomalee in the north to the neighbourhood of Tirukkovil in the south.

(3) *Endemicity high or very high. Spleen rates 40-60 per cent. or over.*—

(*a*) A very extensive area embracing almost two-thirds of the entire Island. It includes the eastern half of the Southern Province, the low-country of the Province of Uva, the greater part of the Eastern and Northern Provinces, the central and northern portions of the North-Western Province, and the whole of the North-Central Province.

B.—Hill-country.

(1) *Endemicity low. Spleen rates from 0-10 per cent.*—

(*a*) An extensive area involving most of the hill-country above 500 metres elevation. It includes the central and southern portions of the Central Province, a considerable portion (Bandarawela, Namunukula, &c.) of the Province of Uva, and small areas in the south of Sabaragamuwa (Balangoda, Rakwana, &c.).

(2) *Endemicity moderate. Spleen rates 10-20 per cent. (Higher rates, 20-60 per cent. in certain localised areas)*—

(*a*) A somewhat restricted area mostly below 500 metres elevation, including the northern and sub-montane portions of the Central Province, and the sub-montane areas of Sabaragamuwa and Uva Provinces.

Carter then states " Perhaps the most interesting and striking result of the survey is the extraordinary difference in the degree of malaria prevalence (as indicated by spleen rates in children) in the moist and dry zones of the low-country. In the moist zone the rainfall is heavy and well distributed throughout the year, the vegetation is luxuriant, and paludic conditions—permanent swamps, pools, rivers and streams, paddy fields, &c.—appear to be everywhere present; and yet the degree of malaria prevalence, except in the neighbourhood of the foothills is surprisingly low. In the dry zone on the other hand, the rainfall is much less heavy, and very dry conditions prevail throughout the greater part of the year, during which period—unless irrigation is undertaken—little surface water is evident and circumstances appear definitely unfavourable for the spread of malaria. But, except in the northern portion of the Jaffna peninsula and in one or two other restricted areas, the whole of this extensive region is intensely malarious ".

Maps Nos. 2 and 3 present an interesting contrast. A study of these maps and of maps Nos. 4 and 5 suggests that the abundant rainfall throughout the year in the south-west quadrant of the Island has made this part of Ceylon more prolific and fruitful as regards agriculture and has at the same time produced conditions unfavourable for malaria, and that these factors have led to an abundant population, while elsewhere the prolonged drought during the period of the south-west monsoon has made the dry zones less fertile and has favoured malaria. There is, however, historical and archæological evidence to show that at one time large tracts of the dry zones were well cultivated and populated. The " ruined cities " of the North-Central Province and the numerous ancient tanks for storing water for irrigation during the dry season, give some indication of the extent to which these areas were once populated and Nicholls (1921) has suggested that malaria was the cause of the depopulation which has taken place during the past thousand years and which, in certain parts, is still proceeding.

(*b*) *Malaria in relation to general morbidity.*—It is of considerable importance in the study of any epidemic disease to have some measure of the normal level of incidence, that is, the incidence which on the average may be accepted at a given season of the year in the absence of epidemics. It is clearly not sufficient to know that so many cases were reported in a given month compared with so many in the previous months or in the corresponding month of the previous year. Such a comparison might be misleading; for instance, a rise in the number of cases might be the normal seasonal rise and afford no cause for alarm or the previous year might have been an epidemic year.

A simple measure often used for determining the normal seasonal incidence for each week or month, is the median value for a corresponding period of a number of previous years. The " median " is the middle value of a series arranged in order of magnitude. This method has advantages over the mean or average in that the median is not affected by years of low or high prevalence. The following is given as an example :—

	Cases notified in January.	Order of Value.
1929	582	2
1930	600	3
1931	1,980 (epidemic year)	5
1932	630	4
1933	540	1
Total for 5 years	4,332	

Median = 600. Mean = 866.

In Ceylon there are 97 Government general hospitals and 211 central dispensaries. The normal seasonal morbidity in each district of the Island has been estimated from the attendance records at the hospital out-patient departments and the central dispensaries by calculating for each institution the median incidence based on the experience of from five to seven previous years.

Dispensary attendance figures, in spite of certain inherent defects such as the impossibility of distinguishing the nature of the disease, the number of subsequent visits from first visits or the relative popularity of the dispensary, afford an excellent series from which to calculate standard curves of seasonal morbidity in different areas. They are unquestionably a more sensitive index of the onset, development and decline of the epidemic than mortality data, and for administrative purposes they are invaluable. Complete weekly records are available from all centres by Tuesday morning of the following week, whereas mortality figures are not available till the end of the following month.

The out-patient attendance figures at each hospital and dispensary have been reviewed month by month for a series of seven successive years and the median or middle figure for each month of the series has been taken as the normal or expected attendance for that month. A few centres had records for only five years and the estimates had to be based on this number. (*Tables 7* (*a*), (*b*), (*c*).)

TABLE 7 (*a*).

Normal Seasonal Morbidity in Ceylon.

Average Monthly Attendances at Dispensaries and Hospitals (1927-34). Chiefly Dry Zone. Dec.-Jan. peak.

District.	Average of 5–7 Years.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly Average.
Kurunegala ..	Attendances * ..	50,470	37,959	37,827	35,227	42,211	42,760	44,166	37,800	31,786	32,883	41,278	55,886	490,253	41,638
	% of average	*121.2*	*101.0*	*90.9*	*87.4*	*101.4*	*106.1*	*106.1*	*90.8*	*78.9*	*79.0*	*102.5*	*134.2*	—	*100*
Puttalam ..	Attendances	6,550	4,584	4,148	3,478	3,774	4,075	3,845	3,971	3,498	3,582	4,525	7,249	53,279	4,525
	% of average	*144.7*	*112.1*	*91.6*	*79.4*	*83.4*	*93.0*	*84.9*	*87.7*	*79.9*	*79.1*	*103.3*	*160.2*	—	*100*
Matale	Attendances	11,389	9,476	9,151	9,468	10,652	10,243	10,700	9,154	8,358	9,415	11,180	14,157	123,343	10,476
	% of average	*108.7*	*100.1*	*87.3*	*93.4*	*101.7*	*101.0*	*102.1*	*87.4*	*82.4*	*89.9*	*110.3*	*135.1*	—	*100*
Anuradhapura ..	Attendances	20,890	15,137	13,947	12,457	13,356	13,456	13,234	11,345	10,283	11,251	15,070	22,694	173,120	14,730
	% of average	*142.2*	*114.1*	*94.9*	*87.6*	*90.9*	*94.6*	*90.1*	*77.2*	*72.3*	*76.6*	*106.0*	*154.4*	—	*100*
Chilaw	Attendances	17,061	13,348	11,527	11,065	14,274	12,111	12,629	11,546	10,698	10,133	12,242	16,179	152,813	12,979
	% of average	*131.3*	*113.8*	*88.7*	*88.0*	*109.9*	*96.3*	*97.2*	*88.9*	*85.1*	*78.0*	*97.3*	*124.6*	—	*100*
Jaffna	Attendances	28,941	26,702	24,629	20,433	20,663	19,233	18,316	17,917	17,903	17,841	18,745	24,430	255,753	21,722
	% of average	*133.2*	*136.0*	*113.3*	*97.2*	*95.1*	*91.5*	*84.3*	*82.5*	*85.1*	*82.1*	*89.1*	*112.4*	—	*100*
Mannar	Attendances	7,153	6,058	5,433	4,648	4,464	4,053	4,145	3,823	3,548	3,763	4,847	6,682	58,617	4,979
	% of average	*143.3*	*134.4*	*108.9*	*96.2*	*89.4*	*83.9*	*83.0*	*76.6*	*73.5*	*75.4*	*100.4*	*133.9*	—	*100*
Mullaittivu ..	Attendances	4,303	2,963	2,920	2,707	3,285	2,762	2,657	2,389	2,225	2,320	3,155	4,221	35,907	3,050
	% of average	*141.6*	*108.1*	*96.1*	*92.1*	*108.1*	*93.9*	*87.5*	*78.6*	*75.7*	*76.4*	*107.3*	*138.9*	—	*100*
Trincomalee ..	Attendances	3,586	3,028	3,155	3,174	3,365	3,036	2,698	2,679	2,591	2,665	3,020	3,839	36,836	3,129
	% of average	*114.5*	*107.1*	*100.8*	*104.8*	*107.5*	*100.2*	*86.2*	*85.6*	*85.5*	*85.1*	*99.7*	*122.6*	—	*100*

* Attendances are corrected for days of the month.

TABLE 7 (*b*).

Normal Seasonal Morbidity in Ceylon.

Average Monthly Attendances at Dispensaries and Hospitals (1927-34). Chiefly Wet Zone.

May-June peak.

District.	Average for 5–7 Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
Kandy	Attendances*	25,004	21,956	23,759	24,104	27,183	25,980	26,226	23,730	21,800	22,663	24,094	26,194	292,693	24,586
	% *of average*	*100.6*	*97.8*	*95.6*	*100.2*	*109.3*	*108.0*	*105.5*	*95.4*	*90.6*	*91.2*	*100.1*	*105.4*	—	*100*
Kegalla	Attendances	17,662	15,947	18,352	19,517	22,080	20,618	19,541	16,464	14,238	13,742	15,831	17,109	211,201	19,737
	% *of average*	*98.4*	*98.5*	*102.2*	*112.4*	*123.2*	*118.7*	*109.4*	*91.7*	*81.9*	*76.6*	*91.1*	*95.3*	—	*100*
Colombo ..	Attendances	41,577	38,378	40,278	37,346	43,344	44,030	44,112	38,353	33,283	33,781	36,743	41,627	473,032	40,175
	% *of average*	*103.9*	*105.8*	*100.3*	*96.1*	*107.9*	*113.2*	*109.8*	*95.5*	*85.6*	*84.1*	*94.5*	*103.6*	—	*100*
Negombo .	Attendances	12,156	11,289	11,024	12,324	14,209	13,856	13,714	11,502	9,639	9,504	10,220	11,812	141 249	11,997
	% *of average*	*101.3*	*104.2*	*91.9*	*106.1*	*118.4*	*119.3*	*114.3*	*95.9*	*83.0*	*79.2*	*88.0*	*98.5*	—	*100*
Matara	Attendances	19,744	18,127	19,588	18,922	20,609	22,580	19,873	15,566	14,371	14,338	13,090	18,663	217,471	18,470
	% *of average*	*106.9*	*108.6*	*106.1*	*105.9*	*111.6*	*126.3*	*107.6*	*84.2*	*80.4*	*77.6*	*84.4*	*101.0*	—	*100*
Hambantota ..	Attendances	22,376	17,043	18,259	17,828	20,571	21,652	19,779	15,374	12,941	14,385	15,172	21,826	217,206	18,448
	% *of average*	*121.3*	*102.3*	*99.0*	*105.5*	*111.5*	*121.3*	*107.2*	*83.3*	*72.5*	*78.1*	*85.0*	*118.3*	—	*100*
Galle	Attendances	12,210	11,556	12,526	10,726	10,795	13,778	12,175	10,984	10,705	10,428	10,820	12,583	141,286	12,000
	% *of average*	*101.7*	*106.6*	*104.4*	*92.4*	*106.6*	*118.7*	*101.5*	*91.5*	*92.9*	*86.9*	*93.2*	*104.9*	—	*100*
Batticaloa ..	Attendances	23,123	22,664	25,182	25,827	26,402	22,661	20,362	20,312	20,401	20,272	20,444	24,709	272,359	23,132
	% *of average*	*100.0*	*108.4*	*108.9*	*115.4*	*114.2*	*101.2*	*88.0*	*87.8*	*91.1*	*87.6*	*91.3*	*106.8*	—	*100*

* Attendances are corrected for days of the month.

TABLE 7 (*c*).

Normal Seasonal Morbidity.

Average Monthly Attendances at Dispensaries and Hospitals (1927-34). Irregular peaks.

		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
Nuwara Eliya ..	Attendances*	5,256	5,047	6,045	6,132	6,689	6,322	6,762	6,369	5,703	6,151	6,175	5,822	72,473	6,155
	% of average	*85.2*	*90.6*	*98.0*	*102.7*	*108.4*	*105.9*	*109.6*	*103.2*	*95.5*	*99.7*	*103.4*	*94.4*	—	*100*
Kalutara ..	Attendances	19,604	18,452	20,047	17,309	20,301	18,694	19,994	18,653	16,516	17,471	18,421	19,744	225,206	19,127
	% of average	*102.5*	*106.8*	*104.8*	*93.5*	*106.1*	*101.0*	*104.5*	*97.5*	*89.5*	*91.3*	*99.5*	*103.2*	—	*100*
Badulla	Attendances	9,474	9,050	10,254	10,402	11,782	12,171	11,091	11,273	12,461	12,202	11,528	11,206	132,894	11,287
	% of average	*83.9*	*88.8*	*90.8*	*95.2*	*104.4*	*111.4*	*98.3*	*99.9*	*114.1*	*108.1*	*105.5*	*99.3*	—	*100*
Ratnapura ..	Attendances	18,455	15,751	17,885	16,690	17,664	16,998	15,948	13,686	12,658	13,768	15,340	19,449	194,293	16,502
	% of average	*111.9*	*105.7*	*108.5*	*104.6*	*107.1*	*106.5*	*96.7*	*83.0*	*79.3*	*83.5*	*96.1*	*117.9*	—	*100*

* Attendances are corrected for days of the month.

The number of attendances varies considerably month by month according to the prevalence of any particular disease, but it is evident that there is a regular seasonal trend in morbidity in each district which varies according to the location of the district in wet or dry zones. Districts in the dry zone generally exhibit a conspicuous December-January wave and a subsidiary wave in May-June, while those in the wet zone show a main May-June wave and a secondary December-January wave. (*Charts 1* (*a*), (*b*), (*c*).)

The seasonal curves in these charts show the relative monthly incidence for each of the 21 districts of Ceylon. It was necessary to correct for the varying number of days in the months; so the standard month was assumed to contain 31 days, and each month's figures were adjusted where necessary. The attendances for each month were then expressed as a percentage of the average for the year. All the districts given in Chart 1 (*a*) lie in the dry zone areas and show similar types of seasonal waves with a December-January peak, but Chart 1 (*b*) includes two dry zone districts, Hambantota and Batticaloa, which exhibit a high seasonal wave of morbidity in the second quarter of the year.

In Matara, Ratnapura, Kalutara, and Nuwara Eliya (*Chart I.* (*c*)) the seasonal waves are not so regular as in other districts.

Causes of Morbidity.—During 1933 there were 3,765,231 patients treated at Government dispensaries and at the out-patient departments of Government hospitals (Director of Medical and Sanitary Services, 1933). It should be noted that this number does not necessarily mean that 3,765,231 individuals attended during the year. Some of the patients visited the dispensary at varying intervals of time in the course of the year and after each interval many became " new cases " in the attendance register. The most frequent causes of attendances at dispensaries are reported to be malaria and fevers, dysentery and diseases of the gastro-intestinal tract, skin conditions and ulcers, ankylostomiasis and chronic rheumatism. One of the well known characteristics of malaria is its regular seasonal periodicity. Gill (1928) has observed that " the seasonal incidence of malaria is ordinarily represented by an inconspicuous wave in the spring and by an autumnal wave of greater magnitude."

The seasonal curve of morbidity in many districts of Ceylon is determined chiefly by the malaria incidence, but other groups of diseases also appear to have seasonal trends in certain districts and to exert some influence on the morbidity curve. Although monthly returns are made from all Government institutions showing the total attendances during the months by special causes, the statement as to cause of sickness cannot be regarded as completely reliable in all cases. Certain of these dispensaries are in charge of qualified medical men and others in charge of apothecaries. Diagnosis in the case of the former tends to be more reliable than in the latter. A study was made of the monthly returns for 1931-33 from 12 dispensaries in charge of medical officers to see if there was any uniformity in the seasonal variation of special causes of sickness in different localities. The results of this study indicated that malaria was probably responsible for the seasonal rises in December-January in the dry zone areas but as far as the evidence went the waves in the wet zones in May-June could not be attributed to malaria alone. For example, Galle and Colombo have similar seasonal curves with the highest peak in June. The out-patients' returns for the Colombo and Galle hospitals afford evidence that the predominating cause of this rise may well be the group of ulcers and skin diseases while dysentery might be said to affect the seasonal waves in Matale.

The results are inconclusive but they show that caution should be exercised in attributing the annual seasonal rises in morbidity in all districts of Ceylon to malaria alone.

SECTION III.

THE EPIDEMIC OF 1934-1935.

1. The area of the epidemic.

(*a*) *The boundaries.*—Soon after the start of the epidemic it became necessary for administrative purposes to give boundaries to the epidemic area and later these boundaries were laid down with rather greater precision as the result of a study of the percentage increases in out-patient attendances. It must be admitted that the boundaries now to be described were fixed rather arbitrarily and are to some extent artificial, more particularly the northern and southern boundaries.

The western limit of the epidemic area is the sea. (*Map No. 6.*)

The northern boundary starts at the coast a little north of Chilaw and the mouth of the Deduru-oya, and first runs northwards parallel to the coast for about twelve miles. It then turns inland and runs in a general easterly direction south of Nikaweratiya, north of Maho, through Galewela and across the Matale-Dambulla road. This boundary lies some miles to the north of the wet zone and traverses sparsely populated country where malaria is normally highly endemic. It must be considered a rather indefinite limit because the northern part of the epidemic area shades off gradually into the hyper-endemic areas further north where at the end of 1934 there was an increased prevalence of malaria.

The eastern boundary runs southward in the Mahaweli-ganga basin on the eastern slope of the hills. It includes the area around Teldeniya and crosses the Mahaweli-ganga about 15 miles from Kandy. This boundary then turns south-west, includes Nawalapitiya and Kotmale but excludes the mass of high mountains to the east. It describes a half circle round this mountainous mass following more or less the 3,000 ft. contour line and crossing numerous deep valleys of tributaries of the Mahaweli-ganga and Kelani-ganga. It runs eastwards in the Ratnapura District to include Balangoda and finally southwards to Embilipitiya.

The southern boundary starts at Beruwala on the coast a little south of Kalutara and the mouth of the Kalu-ganga, crosses the plain and the foothills in an easterly direction and meets the eastern boundary at Embilipitiya. It is an ill-defined boundary since the epidemic was not severe in the southern part of the area and towards Embilipitiya the population is very sparse.

These boundaries enclose an area of 5,800 square miles.

(*b*) *Relationship to administrative areas.*—Of the nine provinces of the Island (*Map No. 7*), four—the North-Western, Western, Central, and Sabaragamuwa—were affected by true epidemic conditions, but not the whole of each of these provinces was involved. Thus in the North-Western Province the Puttalam District escaped, and in the northern part of the Kurunegala District epidemic conditions gave way to the hyper-endemic conditions of the dry zone; all the districts of the Western Province—Negombo, Colombo, and Kalutara—were invaded though the southern part of the Kalutara District was little affected; in the Central Province the mountainous parts of the Nuwara Eliya District remained free from malaria except in the valleys to the north-east, but almost all the Kandy District, and the Matale District with the exception of the thinly populated areas of the north and east, were affected. In Sabaragamuwa Province the whole of the Kegalla District suffered, but the Ratnapura District was much less seriously involved.

(*c*) *Relationship to wet zone and river basins.*—Reference to Map No. 1 shows that the epidemic area lies almost entirely within the wet zone, *i.e.*, the area receiving during the period of the south-west monsoon an average rainfall of twenty inches or more. Over the greater part of the epidemic area the average annual rainfall is at least 75 inches, and in some places reaches 200 inches or even more. To the north, in the Chilaw and Kurunegala Districts, the area of the epidemic invades a part of the dry zone but here, as already explained, it was difficult to draw a sharp line between epidemic malaria and that due to an exaggerated seasonal increase in a highly endemic locality. To the south, epidemic conditions ceased a little short of the boundary of the Southern Province and the Galle District remained healthy, a fact attributable to the greater and more uniform rainfall which occurred in this district.

Much importance has been attached to the influence which the state of the rivers has had in starting and maintaining the epidemic. Map No. 6 shows that the area of the epidemic consists principally of the basins of the four rivers, Deduru-oya, Maha-oya, Kelani-ganga, and Kalu-ganga, which rise in the hills and flow westward through the foot-hills and coastal plain, and, in the Kandy and Matale Districts, of a part of the Mahaweli-ganga basin.

The Deduru-oya (*Map No. 8*) is 87 miles long and rises in low hills at a height of a little more than 1,000 feet in the Kandy and Kurunegala Districts. The greater part of the river and its tributaries flow through flat country between the 100 and 500 feet contour lines. In the higher reaches the bed is rocky but during most of its course the channel is wide, flat, and sandy. The upper third of the Deduru-oya is within the wet zone but the lower two-thirds lie in the dry zone. The river is fed principally by the rains of the north-east monsoon though those of the south-west also contribute, but in almost two out of every three years, the contribution during the south-west monsoon is feeble and the flow of the river is consequently poor. The flow in the lower reaches is further affected by the fact that after rain, much of the water from the upper part of the river is diverted to supply certain of the dry zone tanks. Favourable conditions for Anopheline breeding, therefore, are very apt to occur in the bed of the river and its tributaries during a poor south-west monsoon, and severe outbreaks of malaria are common. Hence, after leaving the hills and until it reaches the coast, the Deduru-oya passes through poorly cultivated, thinly populated, and highly malarious country.

The Maha-oya (*Map No. 9*) is 78 miles long. Its principal catchment area is east of a line joining Kurunegala and Ambanpitiya where the elevation ranges from 500 to 1,000 feet, and the average annual rainfall is 100 to 150 inches. The higher reaches of the river are rocky and the surrounding country is only slightly malarious, but in the low-country the river flows along a wide, flat sandy channel in which, during the dry weather, the water shrinks to shallow slow moving streams and many pools are formed in the sand. The valley here is well cultivated and thickly populated but malaria is definitely endemic up to within a few miles of the coast. The last few miles of the river always contain water and malaria becomes rare near the coast.

The Kelani-ganga (*Map No. 10*) is 93 miles long and a part of its upper catchment area reaches an altitude of a little over 4,000 feet while the average is between 3,000 and 4,000 feet. This river receives a very abundant rainfall which normally keeps the river flowing throughout the year. The Kehelgamuwa-ganga and Maskeliya-oya are the largest tributaries and Dr. J. P. Perera describes this area, in which he was stationed, as a narrow tract of land five miles across and eleven miles long. He says " It is walled in on all four sides by ranges of hills, while another range runs down its middle dividing it into two narrow gutter-shaped valleys. The Aberdeen Falls mark the entry of the Kehelgamuwa-ganga into the eastern valley and the Laksapana Falls mark the entry of the Maskeliya-oya to the western valley. These two rivers run in a northerly direction more or less parallel to each other till they converge and meet at Kalugala to form the Kelani-ganga. The land begins to rise sharply from the very banks of the rivers and the villages and their houses are scattered sparsely on the steep hill sides. The country is rugged and in the absence of roads difficult to traverse. The population in the two valleys is about 6,000. The majority of the people are illiterate and poor. They subsist mainly by working on small holdings in the villages and neighbouring tea estates. Due to the closing down of many of these plantations a large number of people have been thrown out of employment. The other activities in the area are the production of kitul jaggery and arecanut and chena cultivation ". He adds that the district had not been affected by malaria for many years until the present epidemic invaded it at the end of November.

The greater part of the Kelani-ganga is in the 100 to 200 inches rainfall belt, but when twenty miles from the sea it enters the 75 to 100 inches zone. On either bank of this part of the river are extensive rubber and coconut plantations, and a flourishing brick and tile-making industry. The lower reaches usually contain water throughout the year and are navigable by flat-bottomed boats. The Kelani basin, except in the hills, supports a very large and comparatively prosperous population and except for an occasional localized outbreak, suffers little from malaria, though twenty-five or thirty years ago when rubber planting was started the area had a bad reputation for the disease.

The Kalu-ganga (*Map No. 11*) is 70 miles long and rises in the Adam's Peak range where the rainfall is abundant at most seasons of the year. Except near its source and in the submontane zone, it flows through districts which are little affected by malaria. As it nears the coast at Kalutara, it passes through densely populated country which normally is entirely free from malaria. The Kalu-ganga basin was not affected by the epidemic to the same serious extent as the basins of the other four rivers.

The Mahaweli-ganga (*Map No. 12*) is the longest and largest river in Ceylon and after a devious course in a north-easterly direction falls into the sea south of Trincomalee on the east coast. Its upper catchment area in the Nuwara Eliya District is in many parts above 7,000 feet in height, and lies well outside the epidemic area. In the Kandy and Matale districts, however, the river and its tributaries flow through land mostly below 2,000 feet in height where tea, cacao, and rubber are grown, where the population is dense and where usually malaria is absent or only slightly prevalent. It is with this part of the river basin that the north-eastern portion of the epidemic area coincides. After leaving the Central Province the river enters land clothed in thick jungle, sparsely populated and intensely malarious. The river bed varies considerably; in its upper reaches it is generally steep and rocky, but near Kandy there are long stretches of sand and it is possible within a mile or two to see the river under very different conditions (*Photographs 3, 4, 5, and 6*).

(*d*) *Relationship of the epidemic area to population.*—The epidemic area although less than a quarter of Ceylon in extent, contains approximately 3,100,000 of Ceylon's total population of 5,551,000 persons. Generally speaking the epidemic has attacked the most densely populated part of the Island. The exceptions are the Galle and Matara districts of the Southern Province and the Jaffna Peninsula. Map No. 3 shows that in the northern and the south-eastern districts of the epidemic area the population was less dense (100 to 250 per square mile) than elsewhere, but it should be remembered that the map merely gives the average density of the population for any particular district, and not the distribution within the district. In the Kurunegala and Matale districts, for example, there is a dense population in the south which becomes progressively thinner towards the north, while in the Ratnapura District the population is mostly in the north and is very sparse in the south-eastern portion.

Table 8 shows how the population of the affected area has been calculated.

TABLE 8.

Estimated Population of Epidemic Area.

District.	Population Census, 1931.	Areas excluded.	Population.	Total.
Kurunegala	397,239	Wanni hatpattu	41,801	355,438
Chilaw	114,640	—	—	114,640
Matale	129,697	Half Matale north	13,025	100,420
		Half Matale east	16,252	
Kandy	587,916	Half Uda Bulatgama	69,439	509,118
		Quarter Uda Dumbara	9,359	
Kegalla	314,567	—	—	314,567
Ratnapura	263,801	Two-thirds Kukul korale	11,822	246,807
		One-third Kolonna korale	5,172	
Colombo	875,488	—	—	875,488
Negombo	205,761	—	—	205,761
Kalutara	363,785	Quarter Pasdun korale west	18,398	326,359
		One-third Pasdun korale east	19,028	
Nuwara Eliya	235,775	All except quarter Kotmale	181,060	54,715
		Half Uda Hewaheta		
			Total	3,103,313

(*e*) *Relationship with areas of endemic malaria.*—Generally speaking the epidemic invaded the least malarious parts of the country (*Map No. 2*). In most parts of the dry zone, increased prevalence of malaria was not considered to be in the nature of an epidemic. In the North-Central Province, for example, there was an abnormal increase both in the morbidity and mortality due to malaria, but as malaria in this province is hyper-endemic the increase was attributed to a worse malaria season than usual. If there had been no epidemic elsewhere conditions in the North-Central Province would have called for little comment since "bad malaria years" are frequent there. A feature which characterized the epidemic was the suddeness with which a great increase occurred in the number of malaria cases, and because of the prominence of this feature, a portion of the endemic zone of the Kurunegala District has been included in the epidemic area. This sudden rise was very striking at the beginning of the epidemic, and as reports were received at short intervals of time of rapid increases in different districts, it led to the use of the phrase "the spread of the epidemic to a new area". This phrase was, however, later given up as being technically incorrect.

The mountainous country above the 3,000 feet contour line (*Map No. 6*) did not suffer much and remained outside the area of the epidemic. Similarly the Galle and Matara Districts in the south-west corner of the Island remained unaffected, though in April a rather greater seasonal increase of malaria cases than usual took place in the Matara District.

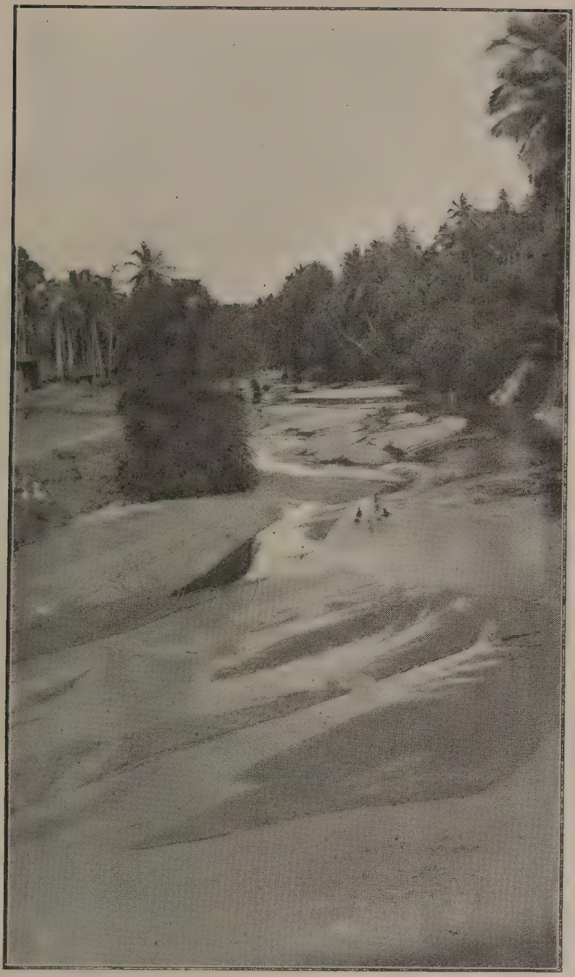
2. **Conditions preceding and during the Epidemic.**

(*a*) *Meteorological conditions and the state of the rivers.*—

Weather Conditions for Ceylon Generally in 1934.—The total rainfall for 1933 had been nearly everywhere above normal, except in the north. During the last four months of that year, however, the rainfall had, on the whole been rather below normal. In January, 1934, the rainfall was fairly heavy, while in February and March it was generally above normal. Taking the Island as a whole a drought started in April and was most marked in July, August, and September. From April to June the rainfall was in most places less than usual except along the south-west coast, while between July and September there was deficient rainfall over the whole Island. The rainy season at the close of the south-west monsoon usually starts in October, and the rains of that month, though still less than normal over a large part of the Island, must have appreciably relieved the drought. The rains of November were also below normal over a large part of the Island, while the December rains were deficient nearly everywhere.

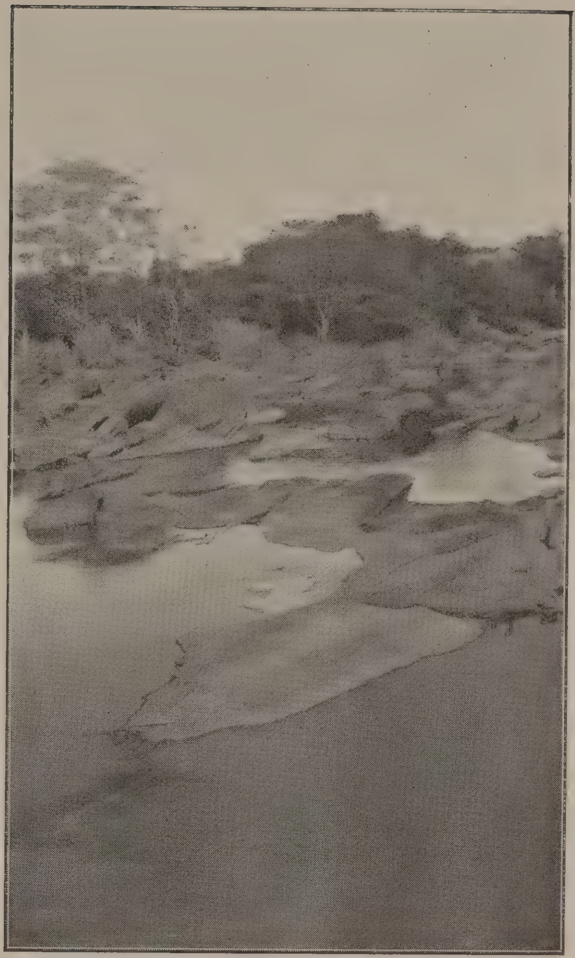
Maps No. 13 and 14 (*a*) and (*b*) show in a graphic manner the offsets from average during the south-west monsoon period over the epidemic zone and the monthly offsets for the Island.

Photograph 3.



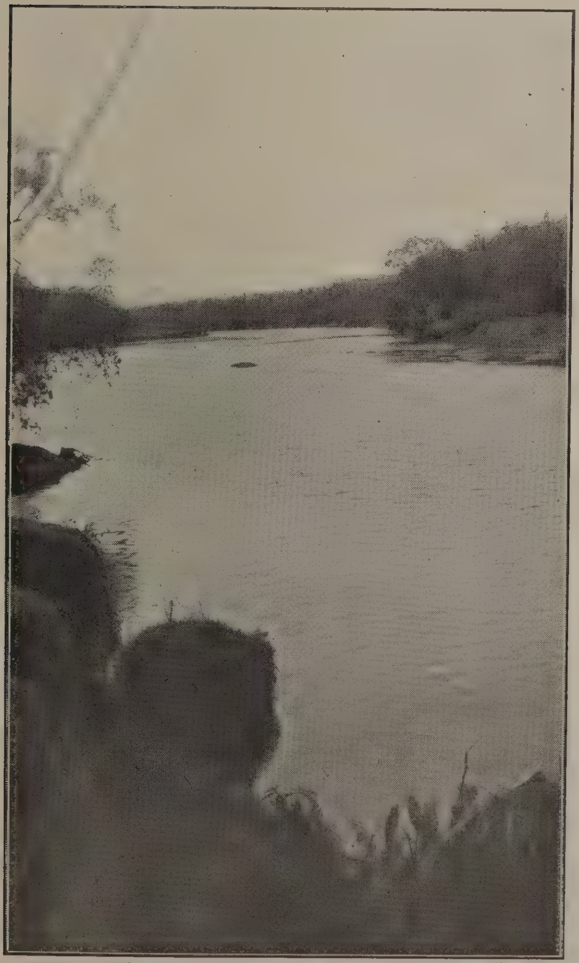
MAHAWELI-GANGA AT KATUGASTOTA, FEBRUARY 23, 1935.

Photograph 4.



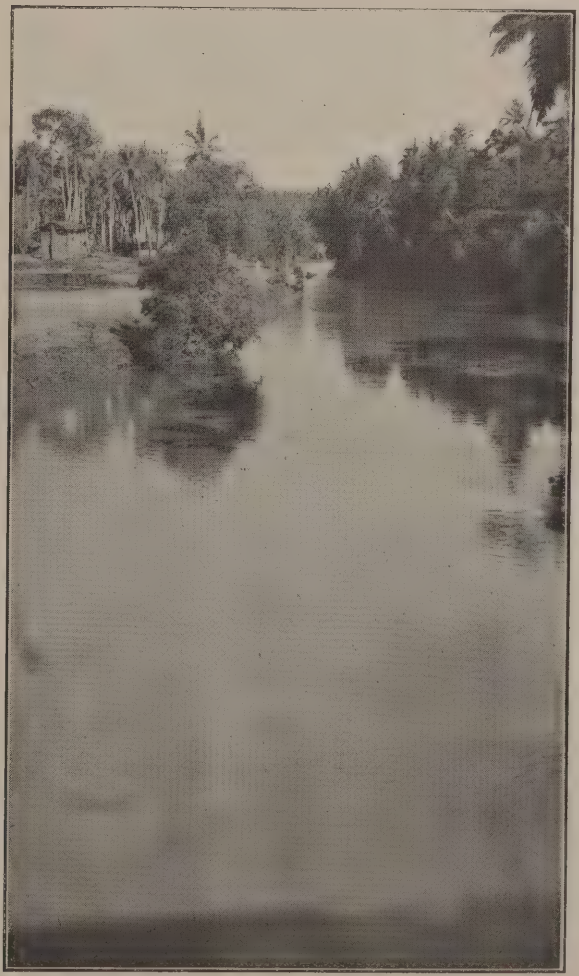
MAHAWELI-GANGA AT HARAGAMA (ON ROAD TO HANGURANKETA) JANUARY, 1935.

Photograph 5.



MAHAWELI-GANGA, $\frac{1}{2}$ MILE BELOW HARAGAMA, JANUARY, 1935.

Photograph 6.



TRIBUTARY OF MAHAWELI-GANGA FLOWING AFTER LOCAL RAIN, FEBRUARY, 1935.

Weather conditions in 1934 in the epidemic zone.—Except at a few stations near the coast, the total rainfall for 1933 was above normal. During the last four months of that year, however, the rainfall was in most places slightly in deficit. In January, 1934, the rainfall was appreciably above normal; in February, on the whole, above normal; and in March above normal over nearly the whole area. In April it was generally below average, except in the south, and in May below average in most districts. In June the rainfall was generally in excess. In each of the three months July, August, September the rainfall was deficient over the whole area. In October it was above normal, except in the north-eastern part of the area. In November in the coastal districts it was generally above normal, while in the inland half of the zone it was below. In December throughout nearly the whole area rainfall was in deficit.

Table 9 shows the rainfall in 1934 for the six months April to September, and for the three months July to September when the drought was most severe, for a number of places in the dry zone and in the epidemic area. For the same periods are given the average rainfall for a number of years, the lowest total recorded up to 1933, and the 1934 rainfall as a percentage of the average. Where the 1934 total is the lowest on record it is shown in italics.

TABLE 9.

Rainfall during the Drought, April to September, 1934.

Epidemic Area.

Stations.	No. of years of observations.	April—September (6 months)					July—September (3 months)				
		Average.	1934 rainfall, and percentage of average.		Lowest up to 1933, and percentage of average.		Average.	1934 rainfall, and percentage of average.		Lowest up to 1933 and percentage of average.	
			Ins.	%	Ins.	%	Ins.	Ins.	%	Ins.	%
Magalawewa	63	23.07	7.82	34	7.40 (1890)	32	6.16	*0.10*	2	0.11 (1911)	2
Horakele	66	30.27	32.68	108	9.15 (1880)	30	8.34	3.00	36	0.55 (1880)	7
Kurunegala Survey	48	37.45	*14.63*	39	23.35 (1914)	62	12.98	*1.99*	15	3.63 (1888)	28
Matale	62	33.73	22.52	67	16.92 (1893)	50	14.23	*3.70*	26	3.87 (1888)	27
Ambanpitiya (Kegalla)	63	57.89	32.50	56	22.98 (1918)	40	23.55	*5.04*	21	5.21 (1918)	22
Kandy	65	41.19	*24.66*	60	28.24 (1884)	69	19.17	*5.45*	28	7.90 (1888)	41
Henaratgoda	44	53.63	41.85	78	23.75 (1911)	44	18.73	4.42	24	4.24 (1892)	23
Avissawella P. W. D.	64	86.37	56.12	65	46.47 (1906)	54	33.65	*7.74*	23	12.58 (1914)	37
Padupola	64	152.77	83.46	55	81.65 (1910)	54	79.44	*26.56*	33	44.22 (1914)	56
New Valley	64	80.64	*44.78*	56	51.47 (1880)	64	38.55	*15.79*	41	17.15 (1918)	44
Kalutara	64	56.51	67.96	120	26.81 (1880)	47	19.69	8.60	44	3.90 (1894)	20
Geekiyanakanda	61	89.31	107.00	120	51.86 (1894)	58	34.58	14.35	41	14.32 (1899)	41
Ratnapura	66	90.39	63.10	70	55.69 (1906)	62	39.73	*15.75*	40	18.61 (1873)	47
Outside Epidemic Area (Dry Zone).											
Puttalam	66	13.49	4.29	32	1.56 1880)	12	2.72	0	0	0 (1875) (1899) (1922)	0
Mannar	65	7.62	3.79	50	0.70 (1880)	9	2.12	0.03	1	0 (1883) (1902)	0
Anuradhapura	65	17.76	13.73	77	4.64 (1911)	26	6.10	1.42	23	0.26 (1922)	4
Jaffna	64	9.62	2.54	26	1.79 (1918)	19	5.10	0.75	15	0.57 (1918)	11
Trincomalee	65	16.52	8.81	53	1.89 (1923)	11	10.49	5.68	54	1.54 (1923)	14
Batticaloa	65	10.83	5.72	53	3.83 (1923)	35	6.13	3.18	52	0.96 (1918)	16
Hambantota	66	14.85	7.32	49	4.50 (1884)	30	5.65	2.01	36	0.37 (1880)	7
Badulla	62	23.02	12.99	56	10.34 (1913)	45	8.73	1.61	18	1.55 (1913)	18
Diyatalawa	34	22.53	22.31	99	13.33 (1918)	59	9.18	3.67	40	2.66 (1922)	29

One of the stations tabulated as being in the epidemic area, New Valley, is just beyond that zone, but it is included as representing the upper reaches of the Kelani river, since the rainfall from this station must appreciably affect the river flow in the epidemic area.

While the April-September, and particularly the July-September totals in the dry zones were generally unusually low, they were not unprecedented; much more severe droughts are on record in these zones. In the epidemic area, however, the April to September rainfall at most stations was but little above the lowest ever recorded. At three stations, Kandy, Kurunegala, and New Valley, it was the lowest on record. Except in the south or near the coast, the rainfall was only about one to two-thirds of the average fall.

The July-September rainfall in the epidemic area was the lowest ever recorded for these three months at nine stations out of the thirteen tabulated, while for two of the remainder it was within a fifth of an inch of the lowest. The two exceptions, Horakele and Kalutara, are both at the edge of the epidemic zone where the outbreak was not severe. The rainfall generally was not more than about a third of the average, and at many places was appreciably less. The effect must have been to reduce the flow, both of the tributary streams and the main rivers, to unusually low amounts for that season of the year.

Rainfall Month by Month in certain River Catchments of the Epidemic Area.—Chart 2 shows the monthly rainfall from June to March in the upper and lower catchments of the three rivers most involved in the epidemic, the Maha-oya, Deduru-oya, and Kelani-ganga, together with the corresponding average figures.

The figures for each catchment were obtained by averaging the figures from a number of rainfall stations in that catchment. The number of stations range from 3 to 10, and as they are neither very closely nor very uniformly spaced over the catchments, the figures can only be regarded as rough approximations. They serve, however, to give a general idea of the character of the rainfall in each catchment.

In every case the drought was more severe in the upper catchments than in the lower. The three lower catchments were only under conditions of severe drought from July to September. For the other months rainfall conditions were normal or even in excess, though drought conditions began to be appreciable again in the latter half of December. The upper catchments suffered appreciable deficit of rainfall for the whole period except in June, when conditions of rainfall were more or less normal, and except in October, when the rainfall again reached average in the case of the two southern rivers.

The rivers and streams of the wet south-western districts do not normally present conditions which favour the intensive breeding of Anopheline mosquitoes. Such rivers, including the Kelani-ganga and Kalu-ganga, usually retain a considerable volume of water which, except in the upper reaches, largely covers the beds and maintains a moderate velocity.

In the hill country the rush of water down subsidiary streams after even a moderate fall is sufficiently powerful to produce a beneficial, clearing effect, but in the low-country (0-200 metres) moderate rainfall after a severe drought, as experienced in 1934, does not successfully flush out the flat, broad, and sandy beds unless precipitation has occurred high up and in fair amount. The smaller streams do generally get flushed after a moderate shower but unless the fall is heavy a great number of rock pools remain untouched (*Photograph No. 2*). The sudden rise and rapid subsidence of rivers and streams is very marked. A fall of just under two inches in the Maha-oya upper catchment was found sufficient to flush the entire width of the bed at Alawwa within twelve hours and equally rapid was the subsidence; pools were forming in four days after the full flushing. Along the Mahaweli-ganga and its tributaries conditions are similar. The large tributary of the Mahaweli-ganga at Katugastota was full in the morning (*Photograph No. 6*) after local precipitation, and by evening the sandy edges were quickly reappearing.

It is reasonable, therefore, to state that unless rainfall is more or less uniformly distributed over a month, rivers and streams are favourable to Anopheline production from time to time. It has also to be noted that the diversion of the water from the smaller streams and tributaries for rice cultivation, affects considerably the amount that reaches the parent stream, especially during the dry season.

During the epidemic, the evidence available indicated strongly that the conditions produced by the prolonged drought in the larger rivers and tributaries draining the affected area were of fundamental importance. The river beds over the greater part of the epidemic zone presented unusual opportunities for Anopheline breeding and there can be no doubt that the output of *A. culicifacies* was far above that of a normal year.

In the upper reaches which generally get empty earlier, rock-pools were formed even quicker than sand-pools in the lower reaches. The onset of dangerous breeding, however, does not altogether coincide with the respective periods of pool formations.

Rice cultivation in the epidemic area is generally supported by streams, and the innumerable small streams that feed the vast area of paddy fields also provided suitable breeding sites for *A. culicifacies*.

The above descriptions make it evident that there was a partial failure of the rains of two successive monsoons and during the period of unprecedented drought—July, August, and September, 1934,—the rivers in the wet zone except in the south, were in an ideal state for the breeding of *A. culicifacies*. This state was interrupted chiefly by the rains of October, but by December, 1934, favourable breeding conditions had become re-established and continued during January, February and the first half of March, 1935.

The following extract from a recent report by Colonel Clemesha gives a lucid summary of the conditions leading up to the epidemic in the Kurunegala District:—

> In the Kurunegala District, the rainfall in the three critical months at our own station (which gives the best indication of the fulness or emptiness of the rivers) was 4.77 in. only. In a period of 27 years, between 1908 and the present time, the two years of greatest drought were 1918 with 9.9 in. and 1913 with 11.4 in. In the previous period of 20 years (the rainfall figures of which are not taken from the same place as the last 27 years) the July, August, and September rains were very deficient in 1888 (probably almost as low as in 1934), in 1890 and in 1893. With the exceptional drought in these months in 1934 malaria accompanied by high death rate was sure to be very prevalent during the autumn.
>
> This condition was in itself bad enough, but there was worse to follow. The north-east monsoon rain which occurs in October, November, and December (frequently going into January) was also deficient; the total rainfall for the Kurunegala District for these three months being about 21 in. which is about half the average fall; in October there was one fairly heavy downpour of about 10 in. With the exception of this one scouring out, the important rivers in the Kurunegala District, the Deduru-oya and Maha-oya, were breeding *A. culicifacies* from July, 1934, to February, 1935, a period of six months.
>
> For the proper understanding of the conditions in the autumn of 1934 and spring of 1935, it is therefore necessary to grasp the fact that the year 1934 was phenomenal in its lack of rain. A failure of one single monsoon is capable, in almost any part of the Island, of producing outbreaks of malaria; a failure of two consecutive monsoons must obviously greatly increase the facilities for the spread of the disease. In this period of 47 years there has never been an occasion when two consecutive monsoons (one south-west and one north-east) have failed. Even in the year 1888 and the others mentioned above, a deficient south-west monsoon was followed by a normal north-east.
>
> The results of the failure of the north-east monsoon coming on top of that of the south-west can only with difficulty be visualized. We have direct evidence that during the whole of this period *A. culicifacies* breeding went on in the rivers on an ever increasing scale, only interrupted for six or seven days at a time owing to local downpours of rain. Had the north-east monsoon rainfall in October, November, and December been normal, no outbreak would have occurred in the Kelani Valley, Ratnapura, and Kalutara Districts; the October rains would have prevented it.*

(*b*) *Anopheline prevalence and infectivity.*—

Infection with malaria parasites of Anopheline mosquitoes in the epidemic and sub-epidemic areas.—Previous work (Carter and Jacocks 1929, Carter 1930) on the natural infectivity of Anophelines carried out in different localities over a period of several years has shown that *Anopheles culicifacies* is the most important vector of malaria in Ceylon. None of the other indigenous species of *Anopheles* has yet been found infected in nature, and no epidemic yet investigated has been shown to be associated with any other mosquito. Infection rates in *A. culicifacies* ranging from 4.8 per cent. to 20.6 per cent., and sporozoite rates from 1.8 per cent. to 19.4 per cent. have been recorded. In one malarious locality where continuous observations were made over a period of two years, sporozoite infections were found from November to May inclusive, the highest rates occurring from December to February.

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* The October rains were above normal except in the north-eastern part of the epidemic area (*vide supra*).

During the present epidemic, collections of Anopheline mosquitoes were made from huts and other dwellings within the affected area from November onwards. The localities visited were distributed over a very extensive area, but attention was given mainly to those situated within the catchment areas of the four large rivers, Deduru-oya, Maha-oya, Kelani-ganga, and Mahaweli-ganga. Epidemic conditions were most intense in the upper catchment areas of the Deduru-oya, the greater part of the Maha-oya basin, and in the vicinity of the Mahaweli-ganga and its tributaries situated north of Kandy.

A total of 5,063 Anophelines was collected from the dwellings during the period November to May. Of these, 88.5 per cent. were *A. culicifacies*, and 8.7 per cent. *A. subpictus*. The remaining species included *A. varuna*, *A. jamesi*, *A. hyrcanus*, *A. tesselatus*, and *A. maculatus*. Approximately 80 per cent. of the mosquitoes obtained were dissected, but infections with malaria parasites were found only in *A. culicifacies*. The results of the examinations of *A. culicifacies* from the basins of the Deduru-oya, Maha-oya, and Mahaweli-ganga (north-west section) are given in Table 10.

TABLE 10.

Natural infections in A. culicifacies.

(Epidemic zone—November, 1934, to May, 1935.)

Month.	River basin.	Mosquitoes dissected.	Infection rate.	Oöcyst rate.	Sporozoite rate.
November	Maha-oya	112	7.1	5.4	2.7
December	Deduru-oya	111	10.8	8.1	6.3
	Maha-oya	207	14.0	8.2	9.7
	Mahaweli-ganga	8	(12.5)	(12.5)	—
		326	12.9	8.3	8.6
January	Maha-oya	94	4.3	2.1	3.3
	Mahaweli-ganga	35	—	—	—
		129	3.1	1.5	2.3
February	Deduru-oya	155	3.2	0.6	2.6
	Maha-oya	36	2.8	2.8	—
	Mahaweli-ganga	132	—	—	—
		323	1.9	0.6	1.2
April	Deduru-oya	218	1.4	0.9	0.9
	Maha-oya	337	4.2	2.4	2.7
	Mahaweli-ganga	4	(50.0)	(25.0)	(50.0)
		559	3.4	2.0	2.3
May	Deduru-oya	482	4.8	1.7	3.7
	Maha-oya	1,696	8.0	3.6	4.9
	Mahaweli-ganga	220	7.7	6.4	3.6
		2,398	7.2	3.4	4.5
Totals	Deduru-oya	966	4.5	2.1	3.2
	Maha-oya	2,482	7.7	3.8	4.7
	Mahaweli-ganga	399	5.0	4.0	2.5
		3,847	6.6	3.4	4.1

The Kelani-ganga catchment area was examined from the end of January to May, but throughout this period adult Anopheline mosquitoes in dwellings were always very scanty; no infected specimens were found. The highest infection rates occurred in December, 1934, when the percentages of mosquitoes found harbouring malaria parasites ranged from 10.8 to 14.0 with a mean of 12.9 for the whole of the area involved. During January, February, and April the rates decreased, the means being 3.1, 1.9, and 3.4, respectively. In May, however, they again increased and ranged from 4.8 to 8.0 with a mean of 7.2. The infection rates obtained in mosquitoes caught in the Maha-oya basin were usually higher than those caught elsewhere, and ranged from 14.0 in December to 2.8 in February with a mean of 7.7 for the whole period.

Dissections of *A. culicifacies* caught in dwellings during December to February in the highly endemic areas situated north of the main epidemic zone gave the following results:—

Month.	Mosquitoes dissected.	Infection rate.	Oöcyst rate.	Sporozoite rate.
December	116	2.6	1.7	1.7
January	219	1.4	0.9	0.5
February	92	1.1	—	1.1
Total	427	1.6	0.9	0.9

The infection rates were definitely less than those found in the corresponding months for the main epidemic zone.

Anopheline prevalence in relation to the epidemic.—The data presented in this part of the report are concerned solely with larval findings. The results of work on the adult mosquitoes are given above in connection with investigations into the natural infectivity of mosquitoes in the epidemic area. Owing to the non-domestic habits of the majority of the indigenous Anophelines, however, records of adult catches alone do not allow satisfactory estimates of the relative prevalence of the different species to be made, and indeed tend rather to produce erroneous or misleading conclusions. More reliable evidence in this respect is offered by observations on the larval forms where the closer limitations of environment and greater uniformity of habits enable more accurate measurements and comparisons to be made.

Field observations were commenced in various localities early in the epidemic period. Most of the areas examined were situated within the epidemic zone or in the adjoining districts. Trained field assistants were stationed at selected centres with instructions to sample potential breeding places of various kinds within their areas; river and stream beds were to be given particular attention. The identification of the material collected was done at the Colombo laboratory. The entomological work on the rivers and streams—many of which owing to failure of the monsoon rains were in a dangerous condition—was also closely associated with mosquito control measures, the direction of which was dependent upon the findings obtained. Subsequently, when the system of larval control measures was reorganized by the Sanitary Engineer (Section V., p. 63), the whole of the epidemic zone was divided into eleven sections and the more important rivers and streams were visited and examined for larvae, once every ten days, by the field assistants.

An analysis of the data obtained showing the percentage distribution of the more important species of Anophelines in the different areas examined is given in Table 11. In this connection it should be mentioned that the investigations were carried out in the surrounding districts and were not limited to the towns from which these districts derive their names.

TABLE 11.

Relative Prevalence of Anopheline Larvae.

December, 1934, to February, 1935.

Area examined.	No. of Anopheline larvae identified.	Percentage Distribution of Species.				
		A. culicifacies.	*A. varuna.*	*A. maculatus.*	*A. subpicius.*	*A. barbirostris* *A. hyrcanus* *A. jamesi* and others.
Anuradhapura	665	24.9	44.5	—	12.8	17.8
Trincomalee	7,782	14.4	40.0	2.4	18.2	25.0
Chilaw	591	9.1	26.7	0.3	6.3	57.6
Kurunegala	21,996	41.6	36.0	0.7	9.5	12.2
Kegalla	14,387	29.5	55.2	1.7	5.3	8.3
Kandy	15,963	28.0	30.2	3.4	31.6	6.8
Colombo (North of Kelani river)	5,130	18.7	29.0	0.2	9.5	42.6
Colombo (immediate vicinity)	2,858	2.0	3.0	—	45.1	49.9
Kalutara	930	2.1	1.0	—	16.4	80.5
Ratnapura	970	4.1	22.6	1.0	17.8	55.7
Galle	248	—	1.2	—	11.3	87.5

A classification of the areas examined in respect of malaria conditions is given below in Table 12 relating to the prevalence of *A. culicifacies*. Facts concerning this mosquito are also discussed below. Here attention need only be directed to the relatively high prevalence of *A. varuna* in all areas except Colombo (vicinity), Kalutara, and Galle, the scarcity of *A. maculatus*, and the predominance of the swamp-breeding species (*A. barbirostris*, *A. hyrcanus*, *A. jamesi*, &c.) at Chilaw and in the wetter districts of the Western Province and Sabaragamuwa.

TABLE 12.

Relative Prevalence of A. culicifacies (Larvae) in Relation to Epidemic Conditions.

December, 1934, to February, 1935.

Nature of Area in respect of Malaria conditions and Climate.	Area.	No. of actual Breeding Places of Anophelines examined. (1)	No. of Anopheline larvae identified. (2)	Breeding places of *A. culicifacies* (per cent.). (3)	River and Stream beds breeding *A. culicifacies* (per cent.). (4)	Situations other than river and stream beds breeding *A. culicifacies* (per cent.) (5)	*A. culicifacies* larvae as per cent. of total Anopheline larvae. (6)	*A. culicifacies* larvae as per cent. of total larvae from River and Stream Beds. (7)	Types of Breeding places other than rivers and streams containing *A. culicifacies*.
I.—*Highly Endemic Area*—									
Increased prevalence during epidemic	Anuradhapura	28	665	43.0	100.0*	40.7	24.9	7.6	Borrow-pits, irrigation channels, wells, pools, drains, tank
Dry Zone	Trincomalee	138	7,782	65.8	Nil†	66.8	14.4	Nil	Borrow-pits and wells (numerous) channels, drains, pools, tanks, paddy fields (scanty)
II.—*Epidemic Area*—									
(*a*) Endemicity moderate to high Severe outbreak Intermediate Zone	Kurunegala	377	21,996	56.2	73.7	43.0	41.6	51.6	Quarries, borrow-pits and wells (numerous) channels, drains, trenches, paddy fields and tanks (scanty)
	Chilaw	59	591	13.5	60.0	9.2	9.1	49.5	Borrow-pits and wells
(*b*) Endemicity low to moderate Severe outbreak Wet Zone	Kegalla	381	14,387	46.0	57.0	10.0	29.5	32.4	Borrow-pits, drains, paddy fields (scanty)
	Kandy	435	15,963	59.5	74.0	16.2	28.0	32.4	do.
(*c*) Endemicity low Moderate outbreak Wet Zone	Colombo (north of the Kelani River	208	5,130	32.2	52.3	19.0	18.7	31.5	Quarries, borrow-pits, wells, pools, drains and paddy fields (scanty)
(*d*) Endemicity low Mild outbreak Wet Zone	Colombo (immediate vicinity)	70	2,858	14.3	33.6	10.5	2.0	10.1	Quarries, drains, wells
	Kalutara	58	930	8.6	33.3	7.3	2.1	6.3	Quarries, borrow-pits, wells
	Ratnapura	77	970	11.7	21.0	2.6	4.1	6.8	Wells
III.—*No Epidemic*—									
Endemicity low Wet Zone	Galle	15‡	248	Nil	Nil	Nil	Nil	Nil	—

* One stream only. † Two streams only in area examined. ‡ No rivers or streams examined.

Further analysis of the data with particular reference to *A. culicifacies* was undertaken, and the results have been embodied in Table 12. Several interesting facts relative to the malaria epidemic are brought out in this table:—

In areas of high endemicity in the dry zone proper (Anuradhapura, and Trincomalee Districts and northern part of Kurunegala District), and (with the exception of Chilaw) in areas severely affected by the malaria epidemic, the percentage of breeding places of *A. culicifacies* found ranged from 43.0 to 65.8, whereas in areas in the wet zone where the epidemic was of a mild nature the percentage ranged from 8.6 to 14.3, and in the Galle area which was not affected by the epidemic, no *A. culicifacies* were found. In general, there was a definite reduction in the percentage of *A. culicifacies* in river and stream beds in the regions of heavier rainfall, *i.e.*, south of the Kelani river including the vicinity of Colombo, Kalutara, and Ratnapura.

The percentage of what may be termed subsidiary breeding places of *A. culicifacies* (*i.e.*, other than river and stream beds) was much greater in areas situated within or adjoining the dry zone than in areas situated in the wet zone. These subsidiary breeding places were of a varied nature and included wells, borrow-pits and quarries, irrigation channels, drains, trenches, pools, tanks and paddy fields. The first three of these types of breeding places were often important sources of *A. culicifacies*. In the drier areas the percentage of subsidiary breeding places containing *A. culicifacies* larvae ranged from 40.7 to 66.8; and in the wet zone from nil to 19.0. Quarries in the wet zone are numerous and if these be eliminated the percentage of subsidiary breeding places will be reduced considerably, *e.g.*, in the Colombo area from 19.0 to 12.0 per cent. It is further evident that in those parts of the wet zone which suffered severely from the epidemic, the river and stream beds were mainly responsible for the propagation of the mosquito carrier. In the Kegalla and Kandy areas no less than 98 per cent. of the larvae of *A. culicifacies* collected were obtained from river and stream beds.

In areas of high endemicity and where epidemic conditions were severe. *A. culicifacies* larvae were definitely more abundant than in areas of low endemicity and where epidemic conditions were mild. In the former areas *A. culicifacies* formed from 9.1 to 41.6 per cent. (Table 12 Col. 6) and in the latter areas from 2.0 to 4.1 per cent. of all Anopheline larvae collected, and were not found in the Galle area where there was little or no malaria.

Examination of the data obtained from the rivers, larger tributaries and streams situated in the four main river basins within the epidemic zone also provided valuable information. The rivers specified are the Deduru-oya, the Maha-oya, the Kelani-ganga, and the Mahaweli-ganga. Detailed descriptions of each of these rivers and diagrams of their catchment areas have already been given (pp. 19 and 20). The field work was done in all of the catchments of the Deduru-oya and Maha-oya, mainly in the upper catchments (B and C) of the Kelani-ganga, and in a relatively small portion (Teldeniya-Katugastota-Gampola area) of catchment B of the Mahaweli-ganga. Of the areas of work previously mentioned the following were situated in the basins of these four rivers:—In the Deduru-oya basin, a small part of the Chilaw and the larger part of the Kurunegala Districts; in the Maha-oya basin, the southern part of the Kurunegala and the northern part of the Kegalla Districts; in the Kelani-ganga basin, the Colombo District and the southern part of the Kegalla District; in the Mahaweli-ganga basin, the Kandy District. It may be noted that in Table 13 the term " main rivers " includes also the larger tributaries; and that the great majority of the sand pools and rock pools examined were situated in the beds of such rivers and tributaries.

TABLE 13.

Prevalence of A. culicifacies in River Basins.

December, 1934, to February, 1935.

	No. of actual Breeding Places of Anophelines examined.	No. of Anopheline larvae identified.	Breeding places of *A. culicifacies.* per cent.	*A. culicifacies* larvae as per cent. of total Anopheline larvae.
I.—*Deduru-oya*—				
Main rivers	48	6,183	87.5	41.8
Associated streams	24	702	37.4	19.1
Sand pools..	26	4,825	92.3	78.2
Rock pools	17	891	100.0	66.2
Total	115	12,601	79.8	56.1
II.—*Maha-oya*—				
Main rivers	134	7,152	65.5	24.3
Associated streams	48	1,191	31.3	17.3
Sand pools	51	1,787	90.2	67.6
Rock pools	48	1,110	56.4	50.3
Total	281	11,240	63.1	33.0
III —*Kelani-ganga*—				
Main rivers	19	1,592	63.2	26.6
Associated streams	22	473	4.5	0.4
Sand pools in bed	68	1,526	56.0	41.5
Rock pools in bed	11	18	9.1	5.6
Total	120	3,609	43.3	29.4
IV.—*Mahaweli-ganga*—				
Main rivers	27	996	35.8	9.8
Associated streams	88	2,931	47.7	7.6
Sand pools..	155	6,154	85.3	38.2
Rock pools	79	2,681	83.5	54.5
Total	349	12,762	71.6	32.4

The results given in Table 13 show that the four rivers in question varied considerably during the period of investigation in respect of *A. culicifacies* prevalence. The Deduru-oya catchment area gave not only the highest percentage (79.8) of breeding places of this mosquito, but also the highest proportion of larvae (56.1) per cent. The Mahaweli-ganga and Maha-oya areas also gave high percentage (71.6 and 63.1 respectively) of breeding places of *A. culicifacies*, but the proportions of larvae of this species to total Anopheline larvae obtained were definitely lower (32.4 and 33.0 per cent.) than in the Deduru-oya. In the upper catchments of the Kelani-ganga breeding places of *A. culicifacies* were less numerous (43.3 per cent.) than elsewhere. Larvae of this mosquito were found in each of the different classes of situations included under the catchment areas. They were by no means confined to pools in the river beds and were found with disturbing frequency in the main bodies of water being present, except in the Mahaweli-ganga area, in from 63.2 to 87.5 per cent. of the large rivers and tributaries where Anophelines were breeding. The smaller streams and tributaries were less often selected for breeding purposes (percentages ranging from 4.5 in the Kelani area to 47.7 in the Mahaweli area) and gave smaller proportions of *A. culicifacies* larvae than the other classes of breeding places. Pools, both in the sandy beds and in rocks were very frequently utilized by this mosquito, its larvae (except in the Kelani) being usually present, in relatively high proportions, in from 80 to 90 per cent. or more of the actual breeding places of Anophelines detected.

Comparison of Prevalence of Anophelines before and during the Epidemic.—A very considerable amount of work on the relative prevalence (larval) of the Anopheline mosquitoes in different parts of Ceylon has been performed during the past several years (*Carter 1927*). Briefly it may be said that *A. culicifacies* is essentially a dry zone mosquito where it is prevalent in the plains and in the hill country up to elevations of 2,000 feet or 2,500 feet. In the wet zone, both in the plains and in the hills, it exists but is everywhere scanty unless changes in conditions, whether natural or artificial, favouring its propagation occur. *A. varuna* is also less abundant in the wet zone and at the higher altitudes. The " swamp breeding " Anophelines *A. hyrcanus*, *A. barbirostris*, *A. jamesi*, *A. pallidus* are widely distributed throughout Ceylon; they are the predominant species of the wet south-western lowlands.

Reference to Table 12 shows that in at least three areas situated in the northern part of the wet zone (Kegalla, Kandy and Colombo, north of the Kelani-ganga) *A. culicifacies* was breeding to a considerable extent and epidemic conditions were severe. Generally speaking *A. culicifacies* is not normally abundant in any of these areas although it is known to be prevalent in certain localities in the neighbourhood of the Maha-oya and Mahaweli-ganga. In the Kegalla area extensive observations were made over a period of three years prior to the epidemic. These observations included regular (monthly) examinations of various types of potential breeding places, *e.g.*, rivers, streams, channels, pools, wells, borrow-pits, paddy fields, &c., at ten selected villages during the year 1931, (*b*) similar situations at an additional seven villages in 1932, and (*c*) river and stream beds in 1933. With the exception of two restricted localities the area investigated was relatively free from malaria and the spleen rates of the resident children seldom exceeded 5 per cent. The work done involved in all the examination of 4,224 different situations and the identification of over 36,000 Anopheline larvae. The number of actual breeding places of Anophelines found was 2,024 (or 48 per cent.). The most abundant species were *A. varuna*, *A. subpictus*, *A. hyrcanus*, *A. jamesi*, *A. pallidus*, and in certain districts *A. maculatus*. *A. culicifacies* larvae were found infrequently and in small numbers. They formed only 0.2 per cent. of the total larvae found and 0.6 per cent. of those obtained from river and stream beds, as against 29.5 per cent. and 32.4 per cent. respectively during the epidemic period. Further, they occurred in only 1.9 per cent. of the actual Anopheline breeding places found against 48.0 per cent. during the epidemic; and in 4.5 per cent. of the positive river and stream beds as compared with 57 per cent. during the epidemic.

(*c*) *Economic Factors.*—The areas of high epidemicity of malaria for the months of October, 1934, to April, 1935, were more or less confined to the heavily populated agricultural districts of the wet zone, where most of the coconut and rubber plantations of Ceylon are situated. Further, there is in these areas considerable cultivation of paddy (rice) and garden produce for local consumption. The brown and green areas in Map No. 4, which demarcate the coconut and rubber cultivation of the south-west of Ceylon, also roughly indicate the localities of the epidemic of malaria.

The Years of Depression.—Ceylon was badly affected by the world wide economic depression; and the exports of the principal crops, namely, tea, rubber and coconut products fell in total value from Rs. 406 millions in 1927 to Rs. 167 millions in 1933. The majority of the villagers of the epidemic areas were not greatly affected by the fall in the price of tea; their welfare depends on coconut products and food crops and to a less extent upon small rubber cultivations. The total value of coconut products was Rs. 77 millions in 1927 and fell to Rs. 28 millions in 1933 and rubber exports fell from Rs. 117 millions to Rs. 22 millions (*Chart 3*) but although the fall in the former appears less than in the latter this does not represent the true position for the villager, because rubber had declined from the price of a boom period whereas coconut products had not.

The Diets of Children of the Labouring Classes.—An inquiry concerning the nature of the diets of the races and classes in Ceylon was started in the middle of 1934. Teachers of schools in the various districts throughout the Island were instructed to question all the pupils whose ages were between 10 and 12 and record on a printed form the comestibles each child had eaten during the previous 24 hours. The returns for about 10,000 children were received.

The following table gives typical examples of the diets of the children of these two classes:—

Daily Indices.

	No. of Children.	Cereal.	Pulses.	Comestibles of animal origin.	Vegetables.	Fruit.	Condiments (curry, &c.)	Beverages. (Tea).
Wesley School.								
Middle class boys	284	3.43	0.22	2.42	2.37	0.41	1.82	1.14
Uva.								
Vernacular schools, labouring class	257	2.71	0.60	0.71	1.48	0.31	1.89	0.32

The composition of the diets of the better classes are more or less adequate with the possible exception of vitamin A; but the diets of the poorer classes are too high in carbohydrates, and definitely deficient in vitamin A. (*Nicholls 1933-34.*)

Thirteen thousand school children have been measured and weighed, and graphs have been drawn up which show that the children of the lower classes are much smaller at every year of life than the children of the upper classes. These figures will be published elsewhere.

Similar numbers of children have been examined for signs of dietary deficiencies such as phrynoderma, " sore mouth ", hypoplasic and decayed teeth, and surveys have been made in hospitals and various institutions for nutritional oedema, marasmus, xerophthalmia, night blindness and keratomalacia, and it has been found that these signs and diseases are prevalent only among the poorest classes. (*Nicholls 1933-34.*)

The drought prior to the epidemic of malaria.—The labouring classes of Ceylon have lived for years on diets sufficient to support a mean existence, but definitely deficient in several constituents, and a high death rate, particularly of infants and children (Section III. 4) was partly the result of this. Their general welfare had been affected by the economic depression, when a serious drought brought further affliction to them.

The acreage on which food crops have been affected, or completely failed because of the drought is not obtainable; but monthly reports by Government Agents and others give the general condition of the crops in each district, and a study of these for the six months, June to December, 1934, enables each of the twenty districts of Ceylon to be placed in one or other of three categories according to the effect of the drought upon the food crops :—

Category I.—Districts in which the crops were affected in very limited areas : Kalutara, Matara, Chilaw, Puttalam, Trincomalee, and Nuwara Eliya.

Category II.—Districts in which the crops were severely affected in limited areas : Ratnapura, Kandy, Galle, Hambantota, Jaffna, Batticaloa, Badulla, Matale, and Colombo.

Category III.—Districts where the crops failed to the greatest degree : Mullaittivū, Anuradhapura, Mannar, Kurunegala, and Kegalla.

The first three districts named in category III. have in normal times a high malarial endemicity and were affected with a marked hyper-endemicity from November, 1934, to February, 1935; and the Kurunegala and Kegalla Districts were more stricken by the epidemic than any other areas.

Even if the masses had been well fed and prosperous there would have been an epidemic of malaria, but the vicious circle of malaria and destitution acting and reacting on one another would not have been established, and the mortality rate would have been lower, convalescence would have been quicker, and probably the infectivity and relapse rates would have been less.

3. **The start and course of the epidemic.**

The year 1934 opened with an exceptionally low malaria incidence in nearly all parts of the Island and during the months of April, May, and June there was no notable outbreak or exacerbation of the disease. But for several months before the epidemic started it was considered that an increased incidence of malaria was likely to occur. In June the Hon. the Minister for Health was informed that " an increase in admissions to hospitals in malarious districts during the months of November, 1934, to March, 1935 ", was anticipated. On October 12 an office minute was written inquiring " in what areas are specific measures to deal with malaria likely to be required as the result of the heavy rain after the prolonged drought " and asking that the " Superintendent, Anti-Malaria Campaign, might give a list and Provincial Surgeons be warned to watch the areas carefully and to take measures as soon as they are necessary ". The Superintendent's memorandum of the 15th October (*Appendix 2*) sets out with considerable accuracy the areas which subsequently suffered from the epidemic, and a point in the memorandum to be noted is that increased malaria was anticipated at a season of the year when it does not normally occur in most of these areas. But although localized outbreaks and a greater general prevalence of malaria were expected, an epidemic of the magnitude of the one which subsequently developed was not contemplated.

Table 14 and Map No. 15 have been drawn up to illustrate the dates on which epidemic conditions first became established in various places, and the names of hospitals and dispensaries mentioned hereafter are given on this map.

TABLE 14.

Date of First Appearance of the Epidemic at Government Hospitals and Dispensaries in each District.

(Rise of over 25 per cent. as compared with previous weeks.)

October 6.	October 13.	October 20.	October 27.	November 3.	November 10.	November 17.	November 24.	December 1.	December 8.	December 15.
Kegalla District. Rambukkana Warakapola	**Kegalla District.** Nelundeniya **Kurunegala District.** Alawwa	**Kurunegala District.** Polgahawela **Ratnapura District.** Kolonna	**Kurunegala District.** Makandura Mawatagama Narammala	**Kegalla District.** Kegalla **Kurunegala District.** Batalagoda Bingiriya Dambadeniya Dandegamuwa Dodangaslanda Hettipola Hiripitiya Katupotha Kurunegala Maho Nikawewa Nikaweratiya Ridigama Wariyapola **Chilaw District.** Chilaw **Kandy District.** Teldeniya **Matale District.** Dambulla Galewala Nalanda Paldeniya Rattota **Colombo District.** Mirigama	**Kegalla District.** Mawanella Niyandurupola **Kurunegala District.** Galgamuwa **Ratnapura District.** Embilipitiya Kahawatta Mahawalatenne **Chilaw District.** Anaivilundawa **Kandy District.** Galagedara Hataraliadda Kadugannawa Katugastota Nawalapitiya **Matale District.** Aluvihare Gammaduwa Kongahawela Matale	**Kegalla District.** Aranayake **Ratnapura District.** Balangoda Pelmadulla **Chilaw District.** Dankotuwa Lunuwila Madampe Marawila **Kandy District.** Eriyagama Madugoda Rangalla **Matale District.** Elkaduwa **Colombo District.** Halpe Ja-ela Kochchikade Minuwangoda Negombo Nugegoda Radawana Ragama Seeduwa Veyangoda **Nuwara Eliya District.** Hanguranketa **Matara District.** Deniyaya	**Kandy District.** Madulkele	**Kegalla District.** Hemmatagama Karawanella Kitulgala Pindeniya Undugoda **Ratnapura District.** Rakwana **Kandy District.** Deltota Doloshage Gampola Kandy (O. D.) Wattegama **Colombo District.** Hanwella Watupitiwala **Nuwara Eliya District.** Ramboda **Kalutara District.** Horana	**Kegalla District.** Deraniyagala Eheliyagoda **Ratnapura District.** Ellagawa Godakawela Kalatuwawa Kalawana Kuruwita Nivitigala Ratnapura **Kandy District.** Kandy (Hospital) Watawala **Colombo District.** Avissawella Gampaha Kadawatta Padukka Pamunugama Pannipitiya Waga **Kalutara District.** Bulatsinhala Horawela Ingiriya	**Kandy District.** Pussellawa **Colombo District.** Hendela Moratuwa **Nuwara Eliya District.** Kotmale Maldeniya **Kalutara District.** Beruwala Kalutara Lathpandura Panadure Pimbura Warakagoda

It was at Alawwa and the surrounding villages on the north bank of the Maha-oya in the south of the Kurunegala District that a noticeable increase of malaria first occurred. The Chairman of the Alawwa Village Committee drew the attention of the District Medical Officer, Polgahawela, to this increase on the 25th September and the branch dispensary at Alawwa, which was then visited twice a week by the District Medical Officer from Polgahawela, was ten days later converted temporarily into a central dispensary with a resident apothecary in charge. The number of patients attending had increased from an average of 130 at each visit of the District Medical Officer in August to 240 at each visit at the beginning of October. After the apothecary was stationed there, the weekly attendances rose from 953 during the week ending October 13, to 3,402 during the week ending 3rd November.

There are numerous dispensaries and hospitals in every district in Ceylon (Section V.) and the people freely visit these dispensaries for medical aid whenever they require it. Therefore any outbreak of disease will be reflected immediately in the dispensary figures of the area involved. It has already been shown that there is a seasonal rise in normal years, but as will be seen later the rise in the number of attendances during the epidemic was out of all proportion to that of any previous year. The normal seasonal attendances at each of the central dispensaries had been estimated (Section II. 3 (*b*)) so it was possible to obtain some measure of the relative intensity of the epidemic in different areas and to compare the attendances at each centre during the epidemic months with the "expected" number for normal years. These figures can only be regarded as giving an indication of the relative intensity of the epidemic and the lowest estimate, because treatment centres were opened all over the epidemic area which relieved the congestion at the central dispensaries, and the attendances at these temporary centres have not been taken into account.

At the beginning of October an increase in the dispensary attendance figures started at Warakapola and Rambukkana, villages situated on the Maha-oya a few miles away from Alawwa (*Map No. 15*).

(*a*) *The epidemic by river basins.*—The following account of the start and development of the epidemic in the various river basins is based on the weekly attendance figures for Government dispensaries and hospitals. These figures are shown for each river basin in Table 15, and Chart 4 graphically illustrates the great rise which took place.

TABLE 15.

Weekly Attendances at Government Hospitals and Dispensaries in River Basins in the Epidemic Area and Rates per 1,000 estimated Population.

August, 1934, to April, 1935.

Week Ending.			Maha-oya.		Deduru-oya.		Kelani-ganga.		Kalu-ganga.		Mahaweli-ganga.	
			Attendance.	Rate per 1,000	Attendance.	Rate per 1,000	Attendance.	Rate per 1,000	Attendance.	Rate per 1,000	Attendance.	Rate per 1,000
1934	August	11	10,319	23.1	5,803	22.7	6,025	9.4	7,853	25.3	8,081	16.1
		18	9,904	22.2	5,758	22.6	6,208	9.6	7,408	23.9	7,848	15.6
		25	9,705	21.7	5,302	20.8	5,783	9.0	6,787	21.9	7,130	14.2
	September	1	9,376	21.0	5,572	21.9	6,042	9.4	7,144	23.0	6,547	13.0
		8	9,371	21.0	5,582	21.9	5,827	9.1	6,476	20.9	7,121	14.2
		15	8,788	19.7	5,378	21.1	5,468	8.5	6,422	20.7	7,083	14.1
		22	9,168	20.5	5,699	22.4	5,339	8.3	6,429	20.7	6,483	12.9
		29	9,580	21.4	6,085	23.9	5,910	9.2	6,925	22.3	6,595	13.1
	October	6	9,828	22.0	5,821	22.9	5,906	9.2	6,843	22.0	6,715	13.4
		13	9,639	21.6	5,836	22.9	4,292	6.7	5,044	16.2	6,753	13.5
		20	10,782	24.1	6,382	25.1	5,394	8.4	6,490	20.9	7,375	14.7
		27	11,636	26.0	6,622	26.0	4,854	7.5	6,214	20.0	7,064	14.1
	November	3	17,766	39.8	11,819	46.4	5,369	8.3	6,611	21.3	8,562	17.1
		10	22,702	50.8	17,215	67.6	4,673	7.3	6,669	21.5	11,475	22.9
		17	28,798	64.5	19,158	75.2	6,424	10.0	8,316	26.8	14,536	29.0
		24	27,704	62.0	16,673	65.5	6,847	10.6	8,303	26.7	14,516	28.9
	December	1	36,574	81.9	18,001	70.7	8,347	13.0	9,235	29.7	15,661	31.2
		8	52,519	117.5	23,568	92.6	18,533	28.8	13,858	44.6	23,405	46.6
		15	71,656	160.4	26,890	105.6	31,457	48.9	22,929	73.8	34,341	68.4
		22	76,364	170.9	30,268	118.9	30,107	46.8	26,748	86.1	36,501	72.7
		29	67,491	151.0	24,726	97.1	32,382	50.3	23,649	76.2	32,509	64.8
1935	January	5	62,479	139.8	20,383	80.1	35,190	54.5	23,900	77.0	30,804	61.4
		12	56,832	127.2	20,208	79.4	32,897	51.1	22,842	73.6	27,699	55.2
		19	54,734	122.5	18,584	73.0	29,780	46.3	20,449	65.9	25,952	51.7
		26	50,276	112.5	16,874	66.3	28,843	44.8	18,401	59.3	23,328	46.5
	February	2	49,157	110.0	18,279	71.8	29,354	45.6	18,355	59.1	23,634	47.1
		9	46,830	104.8	17,433	68.5	29,299	45.5	18,210	58.6	23,742	47.3
		16	43,049	96.3	16,697	65.6	27,411	42.6	17,373	55.9	22,361	44.6
		23	41,805	93.6	15,046	59.1	26,125	40.6	16,599	53.5	21,621	43.1
	March	2	37,959	85.0	13,079	51.4	25,143	39.1	15,420	49.6	20,588	41.0
		9	35,967	80.5	12,137	47.7	22,719	35.3	14,023	45.1	18,844	37.6
		16	34,132	76.4	11,071	43.5	21,819	33.9	13,491	43.4	17,134	34.1
		23	30,546	68.4	10,456	41.1	20,898	32.5	12,798	41.2	16,139	32.2
		30	27,006	60.4	9,881	38.8	19,449	30.2	12,591	40.5	15,924	31.7
	April	6	26,537	59.4	9,130	35.8	19,243	29.9	12,658	40.8	15,476	30.8
		13	28,484	63.7	7,958	31.3	20,762	32.3	14,571	46.9	17,382	34.6
		20	34,876	78.1	9,187	36.1	23,899	37.2	16,564	53.3	21,024	41.9
		27	42,483	95.1	12,136	47.7	26,318	40.9	20,536	66.1	24,961	49.7
	May	4	39,976	89.5	11,626	45.7	24,399	37.9	19,083	61.5	22,937	45.7

Maha-oya.—It is clear from the study of the weekly figures (*Table 15*) that the Maha-oya catchment area was free from epidemic malaria up to October 6, 1934, with the exception of the localized outbreaks at Alawwa, Warakapola, and Rambukkana referred to above, and it is noteworthy that these outbreaks occurred in endemic areas.

From this beginning, rapid diffusion occurred around the middle catchment area of the river. The north-western corner of Beligal korale known as Otara pattuwa was the first to feel the weight of the attack. Nelundeniya was involved in the second week, Polgahawela in the third week, Narammala, Dambadeniya, and Makandura in the last week of October, and Mirigama and Kegalla in the first week of November (*Map No. 15*).

In the upper catchment area, Niyadurupola, Mawanella, Aranayaka, and Gampola exhibited serious rises in the week ending November 17. By this time in the villages round about Alawwa, intense epidemic conditions were prevalent, and by the end of November, the entire river basin was completely in the grip of the epidemic.

The area drained by the Maha-oya was the most intensely affected of all the river basin areas. At the peak of the epidemic the weekly attendances rose to over 76,000, being an attendance rate of 171 per 1,000 population (estimated for the area), compared with a weekly attendance rate of 21 per 1,000 during September.

It will be shown that in some localities the attendance rate was even greater than is indicated by these figures. Attendances at hospitals such as those of Kegalla, Dandagamuwa, and Dambadeniya reached 10,000 a week in spite of the fact that these hospitals were surrounded by newly established treatment centres to intercept the flow of patients and to relieve congestion at the central institutions.

From a weekly maximum of 76,364 on December 22, the attendances declined slowly and by the end of March numbered 27,006. During the latter half of February recrudescences at Halpe, Kochchikade, and Hataraliyadda were responsible for a temporary increase in the figures. Along the coast line the epidemic started late and was not so severe.

Judging from the attendance figures in normal years for the six months, November to April, the centres in this river basin which suffered most were Mawanella with 82,208 attendances during these six months against about 8,000 during the same period of a normal year, Nelundeniya with 70,717 against 7,000 normally, and Warakapola with 47,958 against 5,000 normally. At Kegalla hospital there were 104,456 out-patient attendances against 15,000 normally (Table 18).

Deduru-oya.—The emergence of the epidemic in the Deduru-oya basin was delayed until the last week of October, 1934 (Table 15). Increased dispensary attendance due to malaria was first observed in this area at Mawatagama on October 27, *i.e.*, about a month after the onset of the epidemic at Alawwa. During the next week, however, the epidemic burst with great suddenness and severity almost simultaneously over every part of the river basin, which comprises Weudawili, Hiriyala, and Dewamedi hatpattus (Map No. 15). These localities are in a highly endemic area and it was the suddenness and the magnitude of this increase that distinguished it from the usual seasonal rise in November and led to the inclusion of the localities within the boundaries of the epidemic. There was a lull at the end of November followed by a sharp rise at the beginning of December. The peak was reached early at Hiripitiya (November 17), at Wariyapola (December 8), and at Mawatagama (December 15); but the maximum intensity of the epidemic for the basin as a whole was not reached till the third week of December when the attendances numbered 30,268.

The peak was followed by a more or less speedy abatement of epidemic conditions. During the five weeks that followed, the attendance fell from 30,268 to 16,874. During the first fortnight of February there was a slight increase due to recrudescences at Dodangaslanda, Maho, Mawatagama, and Wariyapola. There was then a steady and continuous decline and by the end of March the weekly attendances totalled only 9,881.

Kelani-ganga.—The Kelani river basin is very large, and is thickly populated except in its upper catchment. It is an area of relatively low endemicity but is subject to minor localized epidemics from time to time. It is in fact the healthiest of the five river basins. It will be seen from Table 15 that during the months preceding the epidemic, the attendances in this valley were considerably lower than in the other basins. Speaking generally, it is safe to state that there was a slight increase in malaria in the last week of November and that the first week of December ushered in definite epidemic conditions. Here, as in the basin of the Deduru-oya, there was a sudden and almost simultaneous outbreak of the disease over a large area. Some idea of the rapidity of development of the epidemic may be formed from the weekly dispensary attendances for the area. The attendance for the week ending December 1 was 8,347, but for the week ending December 15, it was 31,457 (*Table 15*). It is noteworthy that the peak was reached first at Avissawella, Pindeniya, Deraniyagala, and Kitulgala (December 15), but the epidemic as a whole did not reach its maximum intensity in this river basin until the first week of January, 1935 (*Chart 4*), when 35,190 attendances were recorded.

The upper catchment of the river was the more severely affected. Special mention must be made of the moderately severe outbreak of malaria in the Watawala area near the source of the river. The disease broke out here in December, 1934, and was especially noticeable in the valleys of Maskeli-oya and Kahelgamuwe-oya (*Map No. 15*), which for years had been free from malaria.

In the river basin as a whole, the decline was relatively much more prolonged than in the Deduru-oya and Maha-oya basins. From the peak weekly total of 35,190 the attendance declined gradually to 19,449 at the end of March.

Relatively, the worst centre was Pindeniya where the attendances during the six months, November to April, rose from the normal figure of about 5,000 to 46,566—a ninefold increase. Other badly affected centres were Karawanella with 91,680 attendances against a normal figure of 13,604, Avissawella with 83,354 against about 19,000, and Waga with 30,260 against 4,000.

Kalu-ganga.—The basin of the Kalu-ganga comprises a large area situated partly in the Province of Sabaragamuwa and partly in the Western Province. The upper basin includes several endemic areas in Nawadun and Atakalan korales of the Ratnapura District. In the upper catchment, a definite increase of dispensary attendances was noticed at Mahawelatenne and Pelmadulla during the week ending November 10, and in the lower catchment, figures for Horana began to rise about the middle of the month, but the appearance of the epidemic in the rest of the area was delayed until the first week of December. In the week ending December 8, 13,858 attendances were recorded as against 9,225 the previous week. The situation grew worse rapidly. In the upper basin the peak was reached during the week ending December 22, with 26,748 attendances, but in the lower basin the epidemic did not reach its maximum intensity until the first week of January, 1935. The upper basin was more severely affected than the lower, where the epidemic was relatively mild in nature. In Pasdun korale (*Map No. 15*), to the south of the lower section of the river, epidemic conditions did not exist. The decline was very gradual, and by the end of March the attendances had fallen to less than half those recorded in the maximum week.

The worst centres in this basin were Kuruwita where the November to April attendances were 40,765 instead of about 8,000 for the same period of a normal year, Pelmadulla with 36,434 instead of 11,500, Ratnapura with 28,542 instead of 13,000, and Horana with 42,901 instead of 13,400. Kahawatta, Godakawela, Mahawelatenne, Ellagawa, Eheliyagoda, and Ingiriya were also badly affected, but this river basin as a whole appeared to escape lightly as compared with the other river areas.

Mahaweli-ganga.—Almost the whole of Kandy and Matale Districts are drained by the Mahaweli-ganga which is the longest river in the Island. The part of its catchment area involved in the epidemic was 1,815 square miles in extent and had a population of approximately 500,000.

In this river basin epidemic conditions were first observed in the first week of November in Pata Dumbara (Map No. 15), an area of fairly high endemicity which is served by the Teldeniya Hospital. In the second week of November the whole of Matale District with the exception of Laggala pattuwa and the area round about Dambulla, was involved. About the same time the villages round about Kandy were affected and towards the end of November the disease broke out in Yatinuwara which was previously a healthy area. The emergence of the epidemic at Nawalapitiya, however, was delayed until the middle of December. Speaking generally the epidemic reached its maximum intensity in this river basin in the week ending December 22, when 36,501 attendances were recorded, but at Nawalapitiya, where the start was late and the increase slow, the peak was not reached until March. In this river basin as in the Kalu-ganga and Deduru-oya abatement was gradual. By the end of March there were 15,924 attendances—a number only a little less than half of that recorded in the maximum week in December. The brunt of the epidemic was borne by the villages round about Kandy. The Kandy out-door dispensary where the normal figure of attendances during November to April should be about 16,000, recorded 70,405. At Katugastota 73,926 attendances were recorded instead of a normal 18,000, at Eriyagama 29,767 instead of 6,000, and at Kadugannawa 57,525 instead of 12,000. The other badly affected areas were Teldeniya, Matale, Paldeniya, and Galewela where the epidemic figures were two and three times the normal.

(*b*) *The epidemic by districts.*—The river basins are the natural divisions of the epidemic area, but for administrative purposes and because mortality could only be studied by administrative divisions, the data relating to attendances at dispensaries, have also been analysed by districts. These districts are Kurunegala, Kegalla, Chilaw, Matale, Kandy, Colombo, Negombo, Kalutara, Ratnapura, and Nuwara Eliya. The epidemic curves based on weekly attendances at the central dispensaries in these districts are shown in Chart 5, and Table 16 gives the figures from which the chart has been compiled.

TABLE 16.

Weekly Attendances at Government Hospitals and Dispensaries in each District in the Epidemic Area. August, 1934, to April 1935.

Rates per 1,000 Population. Census 1931.

Week ending.	Western Province.				North-Western Province.				Sabaragamuwa Province.				Central Province.			
	Colombo District. (Including Negombo, excluding Colombo Municipality)		Kalutara District.		Kurunegala District.		Chilaw District.		Ratnapura District.		Kegalla District.		Kandy District.		Matale District.	
	Attendance.	o/oo	Attendance.	o/oo	Attendance.	o/oo	Attendance.	o/oo	Attendance.	o/oo	Attendance.	o/oo	Attendance.	o/oo	Attendance.	o/oo
1934 August 11 ..	13,328	16.7	7,002	19.2	10,212	25.7	3,116	27.2	4,567	17.3	5,249	16.7	7,431	12.6	2,729	21.0
18 ..	13,535	17.0	6,618	18.2	10,032	25.3	2,975	26.0	4,366	16.6	5,067	16.1	7,228	12.3	2,684	20.7
25 ..	12,768	16.0	6,000	16.5	9,389	23.6	2,730	23.8	4,157	15.8	4,958	15.8	6,684	11.4	2,554	19.7
Sept. 1 ..	12,814	16.1	5,858	16.1	9,209	23.2	3,074	26.8	4,304	16.3	5,026	16.0	6,066	10.3	2,431	18.7
8 ..	12,421	15.6	5,352	14.7	9,146	23.0	2,095	25.3	4,196	15.9	5,180	16.5	6,453	11.0	2,476	19.1
15 ..	11,633	14.6	5,275	14.5	8,657	21.8	2,659	23.2	4,074	15.4	5,085	16.2	6,313	10.7	2,532	19.5
22 ..	11,349	14.2	5,192	14.3	9,302	23.4	2,718	23.7	4,101	15.5	5,215	16.6	5,959	10.1	2,417	18.6
29 ..	12,068	15.1	5,880	16.2	9,794	24.7	2,730	23.8	4,178	15.8	5,502	17.5	6,116	10.4	2,611	20.1
Oct. 6 ..	11,906	14.9	5,566	15.3	9,808	24.7	2,564	22.4	4,304	16.3	5,774	18.4	6,098	10.4	2,564	19.8
13 ..	9,152	11.5	3,807	10.5	10,095	25.4	2,440	21.3	3,367	12.8	6,082	19.3	5,941	10.1	2,676	20.6
20 ..	11,825	14.8	5,764	15.8	11,187	28.2	2,605	22.7	4,323	16.4	5,302	16.9	6,163	10.5	2,917	22.5
27 ..	11,110	13.9	5,490	15.1	13,160	33.1	2,591	22.6	4,337	16.4	5,443	17.3	6,033	10.3	2,792	21.5
Nov. 3 ..	12,009	15.1	5,523	15.2	25,047	63.1	2,717	23.7	5,007	19.0	7,357	23.4	6,788	11.5	3,662	28.2
10 ..	10,820	13.6	4,257	11.7	31,087	78.3	2,904	25.3	6,185	23.4	11,144	35.4	8,841	15.0	5,370	41.4
17 ..	17,756	22.3	6,112	16.8	34,912	87.9	5,087	44.4	6,962	26.4	12,840	40.8	11,259	19.2	6,825	52.6
24 ..	17,865	22.4	6,620	18.2	33,173	83.5	5,029	43.9	6,536	24.8	12,076	38.4	11,232	19.1	6,545	50.5
Dec. 1 ..	20,540	25.8	7,175	19.7	39,631	99.8	5,707	49.8	7,409	28.1	16,542	52.6	13,090	22.3	6,611	51.0
8 ..	30,036	37.7	7,769	21.4	46,395	116.8	7,831	68.3	11,666	44.2	33,494	106.5	22,179	37.7	8,481	65.4
15 ..	51,805	65.0	11,987	33.0	57,996	146.0	11,553	100.8	18,526	70.2	*49,508*	*157.4*	30,915	52.6	11,380	87.7
22 ..	54,938	68.9	14,266	39.2	*69,847*	*175.8*	12,297	107.3	*20,779*	*78.8*	46,376	147.4	*33,310*	*56.7*	*12,251*	*94.5*
29 ..	54,247	68.1	12,931	35.5	55,982	140.9	*12,761*	*111.3*	19,009	72.1	45,513	144.7	31,039	52.8	10,620	81.9
1935 Jan. 5 ..	*56,269*	*70.6*	15,104	41.5	48,449	122.0	12,232	106.7	17,774	67.4	41,446	131.8	29,520	50.0	9,128	70.4
12 ..	50,275	63.1	*15,737*	*43.3*	44,951	113.2	11,747	102.5	15,680	59.4	38,418	122.1	27,572	46.9	7,903	60.9
19 ..	44,292	55.6	14,358	39.5	41,830	105.3	10,541	91.9	13,567	51.4	38,912	123.7	26,129	44.4	7,096	54.7
26 ..	42,294	53.1	12,877	35.4	38,979	98.1	8,873	77.4	12,659	48.0	36,128	114.8	23,732	40.4	6,201	47.8
Feb. 2 ..	42,790	53.7	13,356	36.7	40,951	103.1	9,252	80.7	12,566	47.6	34,833	110.7	23,716	40.3	6,953	53.6
9 ..	42,447	53.3	12,842	35.3	40,604	102.2	9,276	80.9	12,547	47.6	31,575	100.4	23,603	40.1	6,867	52.9
16 ..	40,297	50.6	12,202	33.5	39,257	98.8	8,830	77.0	11,782	44.7	28,024	89.1	22,354	38.0	6,286	48.5
23 ..	38,866	48.8	11,775	32.4	35,860	90.3	9,258	80.8	11,240	42.6	27,042	86.0	22,107	37.6	5,755	44.4
March 2 ..	36,333	45.6	11,352	31.2	30,403	76.5	8,683	75.7	10,446	39.6	26,284	83.6	19,713	33.5	5,314	41.0
9 ..	34,426	43.2	10,158	27.9	27,789	70.0	8,415	73.4	9,599	36.4	24,342	77.4	18,136	30.8	4,694	36.2
16 ..	32,940	41.3	8,913	24.5	26,072	65.6	8,427	73.5	8,966	34.0	22,643	72.0	16,613	28.3	4,169	32.1
23 ..	30,928	38.8	8,508	23.4	23,571	59.3	7,836	68.4	8,452	32.0	20,488	65.1	15,401	26.2	4,056	31.3
30 ..	28,185	35.4	8,381	23.0	20,992	52.8	7,277	63.5	8,224	31.2	19,218	61.1	15,260	26.0	3,775	29.1
April 6 ..	23,669	29.7	8,586	23.6	19,761	49.7	6,841	59.7	7,739	29.3	19,306	61.4	14,900	25.3	3,643	28.1
13 ..	27,069	34.0	8,268	22.7	17,692	44.5	6,399	55.8	9,420	35.7	22,734	72.3	17,361	29.5	3,392	26.2
20 ..	31,500	39.5	8,609	23.7	19,790	49.8	7,893	68.9	10,914	41.4	27,622	87.8	20,169	34.3	4,388	33.8
27 ..	38,424	48.2	12,387	34.1	24,839	62.5	10,990	95.9	12,592	47.7	30,358	96.5	23,410	39.8	6,048	46.6
May 4 ..	34,980	43.9	11,835	32.5	24,127	60.7	10,289	89.8	11,765	44.6	28,456	90.5	21,585	36.7	5,810	44.8

The districts most seriously affected were, of course, those situated in the upper catchment areas of the Maha-oya and Deduru-oya, viz., Kegalla and Kurunegala. At the height of the epidemic the attendances in the Kurunegala District reached the high figure of 69,847 or a rate of 176 per 1,000 population. In Kegalla District 49,508 was the highest weekly number, equal to a rate of 157 per 1,000.

Chilaw came next in severity with a rate of 111 per 1,000 during the maximum week. With the exception of Chilaw, other districts along the coast—Colombo, Negombo, and Kalutara—suffered much less than the adjacent inland districts. These three coastal districts lie in the lower catchments of the Maha-oya, the Kelani-ganga, and the Kalu-ganga where, as already shown, the epidemic was less severe. The worst part of the Colombo District was the area between the two rivers, Maha-oya and Kelani-ganga. Kandy and Matale are both watered by the Mahaweli-ganga. In Kandy District the maximum attendance in any week was 33,310 or 57 per 1,000 population and in Matale 12,251 or 95 per 1,000. The worst affected parts in Kandy and Matale Districts were those adjacent to Kurunegala and Kegalla Districts, *e.g.*, Galagedara, Tumpane, and Yatinuwara. Teldeniya and some of the valleys to the east of Kandy were moderately affected. Only a small portion of the Nuwara Eliya District was affected. In the most southern district, Ratnapura, which lies in the upper reaches of the Kalu-ganga the epidemic was also of moderate severity.

In all districts the peak was reached in from five to eight weeks from the start of the epidemic. The curves in chart 5 show very clearly the variation in time in the emergence of the epidemic in the different districts, and the wide oscillation in intensity. The curves exhibit one feature in common in that they are all asymmetrical, the rise being more abrupt than the decline. It is of interest to note the similarity in the slope of the curves for Kurunegala and Kegalla, the former an endemic area and the latter only mildly endemic. Tables 17 (*a*) and (*b*) (pp. 33 and 34) are given to illustrate special features of the rise and development of the epidemic in Kegalla and Kurunegala Districts. At some centres sudden abrupt rises took place as compared with slower increases at others. In Kegalla District, for example, at centres such as Hematagama, Kitulgala, Eheliyagoda, Pindeniya, and Deraniyagala where sudden rises occurred, the peak was reached within a week or fortnight whereas at centres such as Nelundeniya, Rambukkana, and Warakapola the peak was not reached for ten weeks. It will be seen from Table 17 (*a*) that in the Kurunegala District the rise and development was much more uniform in time all over the district.

The decline of the epidemic as measured by out-patient attendances, began in the fourth week of December and was fairly rapid for the next few weeks. From the end of January, in spite of the fact that numerous new infections and reinfections were occurring and that there was a high relapse rate, the curve for the epidemic area as a whole fell steadily but slowly until the beginning of March. During this period, however, there were temporary rises in individual parts of the area. After the beginning of March new infections were few, and there was a more uniform and rather more rapid decline until the first week in April. Then, in parts of the Mahaweli-ganga basin and the upper reaches of the Maha-oya, increased attendances began to occur and during the second and third weeks of April a secondary wave of malaria swept over the whole epidemic area. This set-back was not unexpected (*Appendix 3*). In a preliminary report on the epidemic dated 10th January it was stated " In the wet zone localized outbreaks of malaria when they occur, usually follow deficient rainfall from the north-east monsoon and begin in April consequent on pool formation in the rivers during the hot dry weather preceding the break of the south-west monsoon. Therefore, while it is anticipated that the present epidemic will slowly subside during the next two or three months, it is possible that after March there will be a recrudescence which poor economic conditions may intensify ". But at the end of March, the improvement had become so steady that a more optimistic view was taken and a set-back in April was thought unlikely. (*Press communiques of March 22 and 29.*) This fresh wave of malaria was of short duration in certain districts but in others continued to increase in volume until the middle of June. It presented many interesting features and will be described in detail at a later date.

It is impossible to state accurately the number of persons who suffered from malaria during the epidemic. At the height, the outpatient attendances at Government institutions, including temporary centres, were more than 60,000 a day. It was estimated that by the middle of December there had been almost half a million cases, and it seems probable that by the end of April there had been within the epidemic area nearly one and a half million. In order to measure the relative intensity of the epidemic in the districts affected, the total attendances at each of the central dispensaries during six months, November to April, have been expressed as a percentage of the " expected " numbers during these months (Section II., 3 (*b*)). The results are shown in Table 18 (p. 35) for each district in the four Provinces affected by the epidemic. Table 19 (*a*) (p. 38) gives the totals month by month. It should be noted that attendances at the temporary treatment centres have not been taken into account. According to these tables the epidemic was apparently less intense over most of the Kurunegala District than would have been expected from the foregoing text. One reason is that Kurunegala has normally a very high sickness rate at this period of the year, November to March (Section II., 3 (*b*)), and consequently would tend to have a lower index than Kegalla, where the sickness incidence is normally highest in May and June, even though the intensity had been the same in both districts.

TABLE 17 (*a*).

KURUNEGALA DISTRICT.

Weekly Attendances at each Hospital and Dispensary showing rise and development of the Epidemic.

	1934.																					1935.																	
	Aug.			Sept.					Oct.				Nov.				Dec.					Jan.				Feb.				Mar.					April.				May.
	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	2	9	16	23	30	6	13	20	27	4
Hospitals.																																							
Dambadeniya ..	794	680	714	655	616	498	546	700	759	637	849	892	1863	2460	2470	2452	3690	3562	7834	10392	6475	4082	3033	3394	2483	2525	2112	1970	1630	1435	1431	1170	1149	1118	1081	896	1192	1415	1516
Dandegamuwa ..	1458	1385	1246	1273	1196	1199	1205	1071	1016	1097	1139	1146	*1745	1956	2341	2319	3097	5259	9794	10123	7931	7407	6972	6355	6089	6422	6466	6700	6062	5266	4739	4120	3824	3514	3093	2826	3234	4006	4302
Kurunegala ..	1136	1074	1081	1048	1046	1028	1020	986	1072	964	1143	1385	*2763	2909	2557	2648	2941	3922	3275	2959	2116	2608	2853	2549	2170	2578	2345	2402	1694	1620	1757	1609	1574	1526	1444	1322	1598	2200	1866
Nikaweratiya ..	367	410	341	345	321	319	316	426	378	373	369	353	*496	922	1332	1200	1269	1462	1577	2023	1759	872	1002	1000	973	775	868	822	748	823	660	584	559	499	437	501	574	637	642
Ridigama ..	482	549	522	470	446	535	607	656	499	699	697	559	*1011	1833	1881	1449	1335	1309	1385	1980	1042	965	876	785	605	638	606	541	674	710	651	585	498	431	426	357	579	734	686
Dispensaries.																																							
Batalagoda ..	167	195	160	158	173	193	213	213	192	184	232	281	*668	1270	1458	1341	1156	1504	1407	1561	889	663	492	537	400	471	494	460	438	400	341	364	321	297	356	301	289	455	382
Bingiriya ..	568	599	472	526	598	437	509	555	524	604	624	607	*814	1233	1518	1037	1231	1437	2615	4367	3740	3124	2514	2091	1981	2181	2197	2092	1473	1193	1134	1112	939	828	679	613	548	1006	916
Dodangaslanda ..	96	84	59	108	136	163	134	138	159	225	222	200	*543	700	724	556	551	885	818	999	755	448	484	788	666	1076	1340	1240	1180	544	439	451	431	325	288	230	291	438	387
Galgamuwa ..	305	267	326	265	318	254	301	331	441	396	372	390	*498	875	1287	1298	1089	1029	1216	1435	1243	845	667	591	507	477	500	434	379	413	360	341	306	307	375	433	371	489	510
Hiripitiya ..	482	449	477	461	458	469	519	593	541	437	486	528	939	*1375	1616	1400	1174	1189	1378	1579	1543	1200	1049	839	829	745	741	718	787	732	652	602	557	577	572	543	500	682	654
Maho ..	427	392	314	330	341	331	365	409	368	441	449	396	*668	1189	1646	1404	1623	1716	2012	2201	1817	1461	1904	1805	1891	1982	1471	1168	1044	1209	1014	834	832	888	813	703	805	771	833
Makandura .	378	360	367	399	364	277	362	292	351	338	334	449	*667	987	1337	1235	2072	2177	3194	4278	2708	3394	3541	3085	3131	2723	3391	2988	3223	3373	3151	3433	2388	2149	1655	1485	1482	1495	1602
Mawatagama ..	555	510	482	494	509	485	539	555	589	474	681	*777	1584	2416	2087	1986	2442	2916	3461	3249	2728	2046	1962	1641	1697	1970	1694	1547	1464	1312	1083	911	940	938	922	788	813	1063	1075
Narammala ..	718	737	635	536	531	493	535	522	519	565	624	*1076	2170	2204	2512	2769	4150	4655	5076	4615	4577	4567	3882	3829	3773	3805	3985	3712	3555	2739	2332	2278	2136	1665	1730	1558	1409	2029	1854
Nikawewa ..	181	162	124	109	124	127	171	223	203	181	204	*265	410	772	996	813	619	593	815	1245	1036	623	554	375	354	370	349	326	325	257	322	272	289	298	353	349	332	308	306
Polgahawela ..	818	839	759	758	743	748	764	789	871	839	1045	1444	*3098	2884	3867	3736	4749	5598	4368	5166	5120	5231	4971	4389	4370	4399	3724	3759	3589	2945	2669	2448	2079	1469	1332	1205	1693	2165	1849
Wariyapola ..	353	374	379	369	327	288	341	393	360	295	*335	374	869	1239	1460	1141	1210	2264	2009	1944	1663	1451	1526	1307	1254	1384	1487	1649	1573	1295	1410	1315	1228	1090	965	722	916	1013	991
Alawwa ..	342	371	381	400	386	400	464	477	484	953	858	1625	*3402	2682	2487	3233	3689	3340	2841	3673	2810	2908	2764	2699	2339	2269	2084	1994	2029	1611	1330	1467	1528	1336	1275	1389	1346	1837	1593
Katupotha ..	236	257	252	219	198	181	133	152	174	*128	207	172	412	495	486	466	752	1180	1052	1709	1795	1996	1529	1255	1012	1117	983	1005	977	923	863	888	820	736	676	650	695	748	653
Hettipola ..	349	338	298	286	315	232	258	313	308	265	317	241	*427	686	850	690	792	398	1869	4349	4235	2538	2376	2516	2455	3044	3767	3730	3016	1603	1451	1288	1173	1011	1289	821	1123	1348	1510

* Indicates start of the epidemic. Figures underlined denote peak.

TABLE 17 (*b*).

KEGALLA DISTRICT.

Weekly Attendances at each Hospital and Dispensary.

Institutions.	1934.																					
	Aug.			Sept.					Oct.				Nov.				Dec.					
	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29
Hospitals.																					
Aranayake ..	346	295	389	367	319	283	346	371	324	257	273	274	307	344	487*	491	697	1783	1691	1734	1682
Eheliyagoda ..	745	712	677	698	619	661	584	683	585	446	477	558	649	501	606	630	770	1235*	1889	2175	2171
Karawanella ..	535	627	550	633	518	508	504	566	551	457	482	390	478	504	593	586	978*	3228	4465	3809	4898
Kegalla ..	785	600	654	589	618	651	703	707	702	639	385	470	856*	1284	1659	1572	2250	4330	9280	8344	7857
Kitulgala ..	230	212	235	181	182	177	178	211	192	122	153	156	191	156	179	195	306*	1166	1784	1376	1418
Undugoda ..	248	293	226	282	329	296	277	378	366	266	270	236	254	319	381	455	581	1454	1449	1260	1649
Dispensaries.																					
Deraniyagala ..	130	129	107	144	159	161	124	135	122	85	101	128	108	127	169	175	*165	627*	1145	957	801
Hematagama ..	372	345	312	277	321	245	253	261	261	274	216	124	189	276	178	276	610*	1562	2531	1996	1798
Mawanella ..	356	363	354	346	376	354	409	382	385	382	429	406	357	746*	1011	1014	1502	3251	6258	6205	5348
Nelundeniya ..	272	270	233	279	316	356	374	384	453	578*	715	658	1051	2122	2472	2160	2884	4862	4676	5265	5208
Niyadurupola ..	264	262	322	268	324	239	333	294	301	276	264	268	354	499*	555	638	743	1433	2646	2478	2349
Pindeniya ..	163	168	175	174	260	215	217	179	214	159	173	146	205	220	265	272	686*	2868	3211	2723	2794
Rambukkana ..	583	585	483	557	618	653	640	706	918*	934	958	1114	1756	2840	2836	2388	2895	3068	4815	4286	4238
Warakapola ..	220	206	241	231	221	286	273	245	400*	407	406	515	702	1206	1449	1224	1475	2627	3668	3768	3302

Institutions.	1935.																	
	Jan.				Feb.				Mar.					April				May
	5	12	19	26	2	9	16	23	2	9	16	23	30	6	13	20	27	4
Hospitals.																		
Aranayake ..	2199	2156	2381	2428	1952	1752	1869	1974	2079	1660	1499	1445	1359	1698	2623	2936	3402	3377
Eheliyagoda ..	1944	1817	1691	1567	1719	1785	1789	1575	1519	1292	1240	1254	1233	1387	2117	2555	2444	2008
Karawanella ..	4889	4973	5829	5175	5115	4315	3828	4333	4263	4034	3832	3491	3055	3134	3366	3723	3801	3238
Kegalla ..	6983	6193	6395	5041	4759	4520	4094	3675	3225	3007	2688	2565	2249	2253	2290	2934	3398	3490
Kitulgala ..	1161	1100	1058	1329	1335	1247	1062	1087	832	745	715	736	779	739	796	784	840	744
Undugoda ..	1599	1437	1555	1323	1261	1275	1178	1180	1182	1030	1007	903	953	921	878	1205	1212	1140
Dispensaries.																		
Deraniyagala ..	768	891	852	856	819	951	846	697	888	595	614	572	597	697	738	761	829	773
Hematagama ..	1554	1507	1782	1815	1871	1734	1566	1663	1703	1514	1393	951	1199	1163	1377	1459	1376	2292
Mawanella ..	4835	4321	4551	4551	4350	3660	3115	2610	2826	2669	2175	2161	1866	1796	2394	3396	4077	3448
Nelundeniya ..	3886	3759	3769	3702	3545	2764	2198	2008	1945	1860	1543	1327	1199	1154	1134	1693	2244	1988
Niyadurupola ..	1794	1167	1044	846	852	999	826	990	941	983	1071	749	676	632	655	769	782	745
Pindeniya ..	2346	2167	2080	2041	2098	2080	1888	2035	2069	1962	1875	1618	1487	1154	1811	2193	2121	1790
Rambukkana ..	4273	4092	4076	3540	3445	2764	2196	1629	1542	1507	1683	1470	1431	1362	1511	1839	2208	2025
Warakapola ..	3215	2838	1849	1914	1712	1725	1569	1586	1270	1484	1308	1246	1135	1216	1044	1375	1625	1398

* Indicates start of epidemic. Figures underlined denote peak.

TABLE 18.

*Total Attendances at Government Hospitals and Dispensaries during the Six Months November, 1934-April, 1935, compared with the "Expected" Number.***

WESTERN PROVINCE.

Colombo.

Dispensaries.	*Ex-pected.*	Actual.	% *Actual of ex-pected.*
Hanwella	*15,177*	64,269	*423*
Hendala	*5,664*	16,200	*286*
Ja-ela	*25,594*	40,522	*158*
Kadawata	**11,158*	34,640	*310*
Mirigama	*17,649*	43,222	*245*
Nugegoda	*13,030*	22,301	*171*
Padukka	*13,964*	51,713	*370*
Pamunugama	**7,439*	11,071	*149*
Pannipitiya	*5,518*	26,177	*474*
Radawana	**14,344*	21,057	*147*
Ragama	*9,045*	26,693	*295*
Waga	*4,189*	30,260	*722*
Wellampitiya	*5,531*	11,196	*202*
Veyangoda	*14,364*	78,383	*546*
Hospitals—			
Avissawella	*19,242*	83,354	*433*
Gampaha	*23,578*	68,051	*289*
Moratuwa	**16,495*	32,728	*198*
Watupitiwela	*14,148*	52,230	*369*
Total	*236,129*	714,067	*302*

Negombo.

Dispensaries.	*Ex-pected.*	Actual.	% *Actual of ex-pected.*
Halpe	*14,817*	54,398	*367*
Kochchikade	**12,351*	33,475	*271*
Seeduwa	*7,143*	16,946	*237*
Minuwangoda	*11,762*	46,457	*395*
Hospital—			
Negombo	*22,752*	42,498	*187*
Total	*68,825*	193,774	*282*

Kalutara.

Dispensaries.	*Ex-pected.*	Actual.	% *Actual of ex-pected.*
Beruwela	**21,960*	35,848	*163*
Bulathsinhala	*2,921*	13,126	*449*
Horana	*13,712*	42,901	*313*
Horawela	*2,111*	6,799	*322*
Ittapana	*5,687*	8,720	*153*
Lathpandura	*5,070*	9,274	*183*
Warakagoda	*3,209*	12,204	*380*
Hospitals—			
Ingiriya	*5,363*	17,570	*328*
Kalutara	*16,840*	38,914	*231*
Neboda	*3,795*	7,037	*185*
Panadure	*28,601*	69,211	*242*
Pimbura	*4,308*	8,933	*207*
Total	*113,577*	270,537	*238*

* Five years only.

CENTRAL PROVINCE.

Kandy.

Dispensaries.	*Ex-pected.*	Actual	% *Actual of ex-pected.*
Battumulla	*1,241*	2,098	*169*
Eriyagama	*5,789*	29,767	*514*
Galagedara	*9,071*	50,120	*553*
Hataraliyadda	*4,659*	29,552	*634*
Hatton	*5,246*	5,820	*111*
Kadugannawa	*11,831*	57,525	*486*
Kandy O.P.D.	*15,897*	70,405	*443*
Katugastota	*17,946*	73,926	*412*
Madugoda	*2,881*	6,795	*236*
Rangalla	*2,103*	6,614	*315*
Wattegama	*7,902*	23,940	*303*
Hospitals—			
Bogawantalawa	*3,286*	3,022	*92*
Deltota	*2,198*	4,808	*219*
Dikoya	*3,398*	4,295	*126*
Dolosbage	*2,192*	4,795	*219*
Gampola	*10,242*	34,566	*337*
Madulkele	*3,275*	9,832	*300*
Maskeliya	*1,303*	2,127	*162*
Nawalapitiya	*12,755*	40,951	*321*
Pussellawa	*3,070*	7,410	*241*
Teldeniya	*16,560*	45,650	*276*
Watawala	*2,266*	6,459	*285*
Total	*145,111*	520,477	*359*

Matale.

Dispensaries.	*Ex-pected.*	Actual.	% *Actual of ex-pected.*
Aluvihara	**7,393*	15,385	*208*
Elkaduwa	*2,617*	8,023	*307*
Galewela	*7,188*	21,258	*296*
Gammaduwa	*1,233*	9,341	*758*
Kongahawela	*2,462*	6,326	*257*
Pallegama	*1,557*	2,816	*181*
Nalanda	*2,815*	8,656	*307*
Paldeniya	*10,360*	32,589	*315*
Rattota	*4,815*	8,803	*183*
Hospitals—			
Dambula	*5,672*	8,113	*143*
Matale	*18,709*	48,249	*258*
Total	*64,821*	169.559	*262*

Nuwara Eliya.

Dispensaries.	*Ex-pected.*	Actual.	% *Actual of ex-pected.*
Hanguranketa	*†4,462*	13,950	*313*
Kotmale	*3,310*	8,584	*259*
Lindula	*1,790*	2,755	*154*
Maldeniya	*3,493*	5,673	*162*
Nanu-oya	*1,498*	2,731	*182*
Nildandehena	*1,803*	2,905	*161*
Hospitals—			
Agrapatana	*1,470*	946	*64*
Dimbula	*1,867*	2,091	*112*
Maturata	*1,542*	3,741	*243*
Mulhalkele	*2,530*	4,414	*174*
Nuwara Eliya	*4,826*	8,123	*168*
Ramboda	**4,582*	13,915	*304*
Uda Pussellawa	*1,304*	1,183	*91*
Total	*34,477*	71,011	*206*

* Three years only. † Based on five years only.

NORTH-WESTERN PROVINCE.

Kurunegala.

Dispensaries.	*Ex-pected.*	Actual.	% *Actual of ex-pected.*
Batalagoda	*6,618*	18,293	*276*
Bingiriya	*17,276*	43,826	*254*
Dodangaslande	*7,212*	15,302	*212*
Galgamuwa	*11,165*	17,738	*159*
Hiripitiya	*10,452*	24,147	*231*
Maho	*15,207*	34,896	*229*
Makandura	*9,210*	64,759	*702*
Mawatagama	*21,853*	45,206	*207*
Narammala	*20,346*	81,088	*399*
Polgahawela	*17,369*	89,166	*513*
Wariyapola	*17,345*	35,015	*202*
Hospitals—			
Dambadeniya	*14,634*	73,167	*500*
Dandegamuwa	*35,951*	132,210	*368*
Kurunegala	*30,916*	59,059	*191*
Nikaweratiya	*15,545*	24,391	*157*
Ridigama	*7,548*	23,645	*313*
Total	*258,656*	781,007	*302*

Chilaw.

Dispensaries.	*Ex-pected.*	Actual.	% *Actual of Ex-pected.*
Anaivilundawa	*6,478*	22,423	*346*
Dankotuwa	*11,551*	49,054	*425*
Lunuwila	*4,690*	29,350	*626*
Madampe	**12,995*	40,319	*310*
Nattandiya	*10,053*	26,995	*269*
Udappuwa	*5,400*	7,073	*131*
Hospitals—			
Marawila	*9,549*	24,807	*260*
Chilaw	*20,706*	49,329	*238*
Total	*81,422*	249,350	*306*

Puttalam.

Dispensaries.	*Ex-pected.*	Actual.	% *Actual of ex-pected.*
Kalpitiya	*4,251*	5,066	*119*
Mampuri	*4,083*	9,099	*223*
Mundel	*3,051*	6,631	*217*
Hospitals—			
Puttalam	*6,274*	10,873	*173*
Anamaduwa	*12,875*	17,656	*137*
Total	*30,534*	49,325	*162*

* Three years only.

PROVINCE OF SABARAGAMUWA.

Kegalla.

Dispensaries.	*Ex-pected.*	Actual.	% *Actual of ex-pected.*
Deraniyagala	*4,161*	17,486	*420*
Hematagama	**5,634*	35,736	*634*
Mawanella	*7,699*	82,208	*1,068*
Nelundeniya	*7,071*	70,717	*1,000*
Niyadurupola	*4,908*	27,510	*561*
Pindeniya	*5,064*	46,566	*920*
Rambukkana	*13,810*	71,180	*515*
Warakapola	**5,341*	47,958	*898*
Hospitals—			
Aranayaka	*†9,432*	45,731	*485*
Eheliyagoda*	**8,887*	40,312	*454*
Karawanella	*13,604*	91,680	*674*
Kegalla	*14,899*	104,456	*701*
Kitulgala	*3,908*	23,334	*597*
Total	*104,418*	704,874	*675*

Ratnapura.

Dispensaries.	*Ex-pected.*	Actual.	% *Actual of ex-pected.*
Belihuloya	*4,015*	9,458	*236*
Ellagawa	*3,390*	18,948	*559*
Godakawela	*10,728*	23,551	*220*
Kalawana	*2,559*	4,779	*187*
Kuruwita	*8,074*	40,765	*505*
Mahawalatenna	*4,641*	14,012	*302*
Mullendiawala	*1,655*	3,682	*222*
Nivitigala	*3,221*	11,026	*342*
Pelmadulla	*11,578*	36,434	*315*
Kalatuwawa	*5,025*	22,853	*455*
Hospitals—			
Balangoda	*11,910*	25,588	*215*
Embilipitiya	*2,448*	6,241	*255*
Kahawatta	*9,629*	22,000	*228*
Kaltota	*1,451*	1,764	*122*
Kolonna	*5,704*	16,968	*297*
Rakwana	*4,502*	10,959	*243*
Ratnapura	*13,041*	28,542	*219*
Total	*103,571*	297,570	*287*

* Three years only. † Five years only.

** The "expected" number is based on the average for seven previous years unless otherwise stated.

In studying the present epidemic it has been suggested that attendance figures are not a safe index of epidemic conditions owing to the number of disturbing factors involved. It is fully realized that they cannot be taken as an accurate measure of incidence or attack rate in any area because (1) subsequent visits are not distinguished from first visits, (2) cause of sickness is not specified and only total figures have been considered, and (3) the popularity or unpopularity of the officer at any centre may affect the numbers attending.

But, in the absence of any other concurrent epidemic, the enormous increases in attendances could only be attributed to the prevalence of malaria. If one compares the number of attendances for the six months from November to April during 1934-35 with the estimate of normal attendance (which is also subject to the errors given above) calculated from an average of the seven previous years, during which there had been no serious fluctuations above the seasonal variation, the excess above the estimated normal can be assumed to be due to the epidemic.

(*c*)*Malaria in Colombo and other coastal towns.*—Colombo has been free from malaria for many years, and the densely populated coastal towns of the Western Province also are almost free from malaria in normal times. But during the epidemic period from October 1 to March 30, 1,778 patients who were resident in the city of Colombo were admitted with malaria to the General Hospital.

Week-ending.		Total admissions.	Malignant tertian.	Benign tertian.
1934 October	6	5	0	1
	13	6	2	2
	20	5	0	3
	27	4	—	1
November	3	8	3	2
	10	8	3	2
	17	17	4	5
	24	11	2	1
December	1	23	5	6
	8	43	8	19
	15	106	42	21
	22	181	75	16
	29	162	57	12
1935 January	5	168	46	31
	12	181	69	31
	19	138	48	29
	26	120	32	27
February	2	106	42	20
	9	102	37	21
	16	68	10	18
	23	74	11	10
March	2	60	15	15
	9	44	4	15
	16	46	8	10
	23	50	7	18
	30	42	6	15

The following table shows the districts in Colombo in which these 1,778 patients were resident. The number of patients from each district are shown in Map No. 16 :—

	Maradana	Dematagoda	Pettah	Kotahena	Slave Isand	Grandpass	Borella	Cinnamon Gardens	Wellawatta	Mutwal	Colpetty	Welikada	St. Pauls	Fort	Bambalapitiya	San Sebastian	Maligakanda	Maligawatta	Mattakkuliya	Timbirigasyaya	Havelock Town	New Bazaar	Narahenpitiya
October	3	4	2	1	2	1	3	2	1	1	1	0	0	1	0	0	0	1	0	0	1	0	0
November	10	5	4	2	3	4	6	0	2	1	1	0	0	0	1	1	0	0	0	0	2	7	0
December	90	49	56	48	19	33	37	24	22	29	20	22	7	8	17	7	16	10	4	5	6	3	7
January	125	63	47	47	38	36	35	33	33	29	28	24	14	14	13	13	11	10	8	8	7	6	4
February	60	35	40	17	18	18	17	6	23	13	16	2	1	6	6	12	4	5	2	0	2	15	3
March	39	22	31	19	6	5	7	7	8	9	11	0	1	1	11	3	1	3	2	2	2	9	0
	327	178	180	134	86	97	105	72	89	82	77	48	23	30	48	36	32	29	16	15	20	40	14

Total .. 1,778

In addition to these patients large numbers were treated privately or at dispensaries within the town. It is certain that the majority of these patients were not infected within the town limits. There is a large amount of motor bus and railway traffic to and from Colombo and traders and other residents in the town frequently travel into the provinces, and during the epidemic many patients from the infected areas came to Colombo for treatment and stayed with relatives.

A list of 1,244 patients, who had given Colombo addresses, was forwarded to the Medical Officer of Health of Colombo for investigation, and he reported that only 136 of them had acquired the infection in Colombo. The following table gives the number of cases contracted in various areas:—

District.	Number of cases.	District.	Number of cases.
Mutwal	47	Kollupitiya	2
Dematagoda	27	St. Sebastian	2
Wellawatta	23	New Bazaar	1
Maradana North	11	Cinnamon Gardens	1
Maradana South	10		
Slave Island	5		136
Timbirigasyaya	4		
Kotahena	3		

The Police are practically the only controlled population in Colombo, and Dr. C. G. Hoole studied cases of malaria among them to find out, if possible, the number of policemen who acquired malaria in Colombo during the epidemic.

The strength of the Colombo police force is 1,356, and many of them live in barracks or married quarters situated in various districts in the town. Needless to state complete records are kept of the transference of any policeman and of the leave taken by him, so that his place of residence is known for any period of time.

There was a considerable amount of malaria among the police, and Dr. Hoole first excluded all cases in which the disease had obviously been contracted at outstations; he then selected 151 cases of policemen admitted to hospital with malaria and closely studied their history sheets and records. He gives the following table to show the number of those who contracted malaria in Colombo and those who contracted it away from the town according to their places of residence within the town:—

District-Barracks.	Number of Patients.	Number who were infected in Colombo.	Number who were infected outside Colombo.
Maradana	63	44	19
Borella	20	18	2
Slave Island	16	14	2
Fort	13	6	7
Modera and Grandpass	10	6	4
Cinnamon Gardens	8	6	2
Pettah	6	3	3
Wellawatta	6	1	5
Kollupitiya	5	1	4
Kotahena	3	1	2
Foreshore	1	0	1
	151	100	51

Reference to Map No. 16 will show that the majority of these patients acquired malaria when residing fairly near the outskirts of the town.

It is impossible to determine accurately the number of cases of malaria contracted in Colombo. A larval survey of the town and its environs was carried out and *A. culicifacies* was found breeding in 31 places within the municipal limits and in 9 places just outside these limits. These breeding places are marked on Map No. 16. But apart from the breeding of *A. culicifacies* within town limits, it is possible that infected mosquitoes which were so numerous a few miles from Colombo were brought into the town in motor buses, trains, and other vehicles.

Negombo.—The first infections took place early in December, 1934, and the epidemic was at its worst towards the end of December, 1934, and early in January, 1935. A definite decrease in numbers was noticed from April. During the worst months the numbers treated were well over 5,000.

Moratuwa.—Cases of malaria among residents were first noticed towards the end of December; and by the middle of February, 1935, no fresh cases were reported. In all a few hundred cases only occurred.

Panadure.—The first cases among residents occurred towards the end of November, 1934, and the largest number occurred in January, 1935. From that month there was a decline and by April no new cases were noticed. Only a few hundred of town residents contracted malaria during the epidemic.

Kalutara.—The first infections were noticed towards the end of December, 1934, and cases continued till the early part of March, 1935. Only a few hundred cases occurred among residents.

(*d*) *Morbidity outside the epidemic districts.*—In parts of Ceylon outside the epidemic area an excessive amount of sickness, much of which was due to malaria, was experienced during the period of the epidemic. An indication of the extent of the increase in sickness is given in Tables 19 (*a*) and (*b*) which show month by month for Government hospitals and dispensaries the total out-patient attendances during the epidemic period and the " expected " attendances in a normal year. The effect of this increased sickness on mortality is discussed later (page 39). Health conditions remained normal only in two districts—Batticaloa and Jaffna. In the hyperendemic districts, particularly Anuradhapura and Hambantota, the seasonal prevalence of malaria was very much greater than usual and in other districts such as Matara and Trincomalee the attendances from December to February were double or nearly double those " expected " at that period. Galle and Badulla showed an unfavourable incidence of sickness from July onwards, Mullaittivu from August and Puttalam from November. It is doubtful whether this increase of sickness, which was not all due to malaria, can be attributed in any degree to the economic depression because during the years 1932 and 1933 when the depression was at its depth, the public health of Ceylon had apparently not suffered. The failure of crops may have had a slight influence and in most areas the crop failure coincided in point of time with the epidemic and in a few areas preceded it. It will be of interest to note to what extent the health of neighbouring countries deteriorated during the same period.

TABLE 19 (*a*).

Monthly Totals of " Expected " and Actual Attendances at Government Hospitals and Dispensaries in each District affected by the Epidemic, July, 1934, to April, 1935.

Districts.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.
*Colombo—										
Expected†	*44,112*	*38,353*	*33,283*	*33,781*	*36,743*	*41,627*	*41,757*	*38,378*	*40,278*	*37,346*
Actual	46,814	45,846	40,058	38,634	52,059	156,747	169,522	126,847	101,864	101,864
% Actual of expected	(106)	(120)	(120)	(114)	(142)	(377)	(406)	(331)	(266)	(273)
Negombo—										
Expected	*13,714*	*11,502*	*9,639*	*9,504*	*10,220*	*11,812*	*12,156*	*11,289*	*11,024*	*12,324*
Actual	11,380	12,353	10,121	10,589	16,592	46,290	37,560	30.893	29,815	32,62
Per cent.	(83)	(107)	(105)	(111)	(162)	(392)	(309)	(274)	(270)	(265)
Kalutara—										
Expected	*19,994*	*18,653*	*16,516*	*17,471*	*18,421*	*19,744*	*19,604*	*18,452*	*20,047*	*17,309*
Actual	28,613	28,393	22,315	23,289	25,437	52,391	63,355	48,420	38,885	42,049
Per cent.	(143)	(152)	(135)	(133)	(138)	(265)	(323)	(262)	(194)	(243)
Kandy—										
Expected	*26,226*	*23,730*	*21,800*	*22,663*	*24,094*	*26,194*	*25,004*	*21,956*	*23,759*	*24,104*
Actual	30,779	29,619	25,248	26,420	43,579	124,072	112,982	84,169	71,117	84,558
Per cent.	(117)	(125)	(116)	(117)	(181)	(474)	(452)	(383)	(299)	(351)
Matale—										
Expected	*10,700*	*9,154*	*8,358*	*9,415*	*11,180*	*14,157*	*11,389*	*9,476*	*9,151*	*9,468*
Actual	12,012	11,516	10,643	12,532	26,142	46,680	33,605	25,031	18,246	19,855
Per cent.	(112)	(126)	(127)	(133)	(234)	(330)	(295)	(264)	(199)	(210)
Kurunegala—										
Expected	*44,166*	*37,800*	*31,786*	*32,883*	*41,278*	*55,886*	*50,470*	*37,959*	*37,827*	*35,227*
Actual	40,803	39,463	36,118	48,763	123,767	215,709	156,607	121,422	90,445	73,957
Per cent.	(92)	(104)	(114)	(148)	(300)	(386)	(310)	(320)	(239)	(210)
Chilaw—										
Expected	*12,629*	*11,546*	*10,698*	*10,133*	*12,242*	*16,179*	*17,061*	*13,348*	*11,527*	*11,065*
Actual	14,536	14,703	13,134	12,932	22,627	54,434	53,615	40,625	38,730	39,319
Per cent.	(115)	(127)	(123)	(128)	(185)	(336)	(314)	(306)	(336)	(355)
Ratnapura—										
Expected	*15,948*	*13,686*	*12,658*	*13,768*	*15,340*	*19,449*	*18,455*	*15,751*	*17,886*	*16,690*
Actual	19,738	19,029	16,897	18,565	28,696	75,158	63,176	46,648	37,866	46,026
Per cent.	(124)	(139)	(133)	(135)	(187)	(386)	(342)	(296)	(212)	(276)
Kegalla—										
Expected	*19,641*	*16,464*	*14,238*	*13,742*	*15,831*	*17,109*	*17,662*	*15,947*	*18,352*	*19,517*
Actual	22,988	21,576	20,989	24,127	51,502	185,313	161,848	110,653	89,712	105,846
Per cent.	(117)	(131)	(147)	(176)	(338)	(1083)	(916)	(694)	(489)	(534)
Nuwara Eliya—										
Expected	*6,762*	*6,369*	*5,703*	*6,151*	*6,175*	*5,822*	*5,256*	*5,047*	*6,045*	*6,132*
Actual	7,416	7,419	6,407	7,000	8,082	14,672	12,777	10,438	10,473	14,569
Per cent.	(110)	(116)	(112)	(114)	(131)	(252)	(243)	(207)	(173)	(239)

* Excluding Municipality.

† Based on the median values for 7 previous years except in a few instances where only five years experience was available.

TABLE 19 (*b*).

Monthly Totals of " Expected " and Actual Attendances at Government Hospitals and Dispensaries in each District outside the Epidemic Area, July 1934, to April, 1935.

Districts.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.
Galle—										
Expected	*12,175*	*10,984*	*10,705*	*10,428*	*10,820*	*12,583*	*12,210*	*11,556*	*12,526*	*10,726*
Actual	16,309	17,279	16,438	14,105	15,691	23,781	23,502	18,300	18,705	17,485
% Actual of expected	(134)	(157)	(154)	(135)	(145)	(189)	(192)	(158)	(149)	(163)
Matara—										
Expected	*19.873*	*15,566*	*14,371*	*14,338*	*15,090*	*18,663*	*19,744*	*18,127*	*19,588*	*18,922*
Actual	19.646	19,231	17,191	16,480	22,653	36,366	37,088	35,309	32,378	38,290
Per cent.	(99)	(124)	(120)	(115)	(150)	(195)	(188)	(195)	(165)	(202)
Hambantota—										
Expected	*19,779*	*15,374*	*12,941*	*14,385*	*15,172*	*21,826*	*22,376*	*17,043*	*18,259*	*17,828*
Actual	17,491	16,288	13,826	14,299	23,661	48,894	48,055	38,519	31,530	28,532
Per cent.	(88)	(106)	(107)	(99)	(156)	(224)	(215)	(226)	(173)	(160)
Jaffna—										
Expected	*18,316*	*17,917*	*17,903*	*17,841*	*18,746*	*24,430*	*28,941*	*26,702*	*24,629*	*20,433*
Actual	19,813	19,713	19,897	19,616	20,255	27,094	31,242	25,729	26,200	21,952
Per cent.	(108)	(110)	(111)	(110)	(108)	(111)	(108)	(96)	(106)	(107)
Mannar—										
Expected	*4,145*	*3,823*	*3,548*	*3,763*	*4,847*	*6,682*	*7,153*	*6,058*	*5,433*	*4,648*
Actual	4,673	4,722	4,048	4,426	5,215	7,552	9,177	7,025	6,099	5,372
Per cent.	(113)	(124)	(114)	(118)	(108)	(113)	(128)	(116)	(112)	(116)
Mullaittivu—										
Expected	*2,657*	*2,389*	*2,225*	*2,320*	*3,155*	*4,221*	*4,303*	*2,963*	*2,920*	*2,707*
Actual	2,787	2,868	2,656	2,905	4,010	6,729	7,431	5,850	5,552	4,526
Per cent.	(105)	(120)	(119)	(125)	(127)	(159)	(173)	(197)	(191)	(167)
Batticaloa—										
Expected	*20,362*	*20,312*	*20,401*	*20,272*	*20,444*	*24,709*	*23,123*	*22,664*	*25,182*	*25,827*
Actual	20,435	19,841	19,591	19,956	20,913	23,057	25,847	24,757	27,552	29,802
Per cent.	(100)	(98)	(96)	(98)	(102)	(93)	(112)	(109)	(109)	(115)
Trincomalee—										
Expected	*2,698*	*2,679*	*2,591*	*2,665*	*3,020*	*3,839*	*3,586*	*3,028*	*3,155*	*3,174*
Actual	2,390	3,012	2,669	2,615	3,728	7,467	6,989	5,055	4,282	3,571
Per cent.	(89)	(112)	(103)	(98)	(123)	(195)	(195)	(167)	(136)	(113)
Puttalam—										
Expected	*3,845*	*3,971*	*3,498*	*3,582*	*4,525*	*7,249*	*6,550*	*4,584*	*4,148*	*3,478*
Actual	4,572	4,364	3,252	3,815	7,761	13,297	10,495	6,992	5,657	5,139
Per cent.	(119)	(110)	(93)	(107)	(172)	(183)	(160)	(153)	(136)	(148)
Anuradhapura—										
Expected	*13,234*	*11,345*	*10,283*	*11,251*	*15,070*	*22,694*	*20,890*	*15,137*	*13,947*	*12,457*
Actual	14,853	14,086	13,009	16,102	33,594	52,324	43,749	27,086	22,165	21,346
Per cent.	(112)	(124)	(127)	(143)	(223)	(231)	(209)	(179)	(159)	(171)
Badulla—										
Expected	*11,091*	*11,273*	*12,461*	*12,202*	*11,528*	*11,206*	*9,474*	*9,050*	*10,254*	*10,402*
Actual	14,241	14,281	14,344	16,596	18,512	18,722	16,495	14,020	15,756	16,794
Per cent.	(128)	(127)	(115)	(136)	(161)	(167)	(174)	(155)	(154)	(161)

4. Mortality during the Epidemic.

(*a*) *Effect on General Death Rate.*—No epidemic within recent years has been so fatal as the malaria epidemic of 1934-35. During the six months from November to the end of April in the districts affected by the epidemic the deaths registered numbered 92,556, and exceeded by 59,144 the average for this period for four previous years, which was 33,412. In the districts outside the epidemic area there were 37,195 deaths as compared with an average of 26,724 for four previous years, showing an excess of 39 per cent. The effect of the epidemic on the general death rate in Ceylon can be summarized by comparing the quarterly death rates during the epidemic period with the corresponding figures for previous years. The death rates in a quarter are expressed as annual death rates, and imply that if the mortality within that particular quarter had prevailed during the remainder of the year then the annual deaths would be four times the quarterly value.

	1932.		1933.		1934.		1935.	
Quarter of the year.	No. of deaths.	Death rates. o/oo	No. of deaths.	Death rates. o/oo	No. of deaths.	Death rates. o/oo	No. of deaths.	Death rates. o/oo
1st	32,099	24.0	34,408	25.7	30,611	22.1	81,873	60.7
2nd	25,301	18.9	25,871	19.1	26,641	19.3		
3rd	26,612	18.1	27,008	20.0	27,985	20.2		
4th	28,637	21.0	27,413	20.0	41,833	30.2		
Total	110,649	20.5	114,690	21 2	127,070	22.9		

Normally the highest mortality is recorded in the first quarter of the year, January being the month of maximum mortality in Ceylon (*Chart 1*) though, as the Registrar-General notes, this may be due " to registration of events occurring in December being delayed till January on account of the Christmas holidays ".

In 1934 this season order of mortality was changed, the mortality of the last quarter exceeding that of the first by nearly 50 per cent. During the second and third quarters the mortality was of the same order as in the previous year but in the fourth quarter of 1934 the deaths registered, 41,833, were the highest number that has been recorded since the influenza epidemic of 1918, which claimed 68,314 victims in the last quarter of that year when the epidemic was at its worst.

In the first quarter of 1935, the deaths were more than doubled, 81,873 were registered, an excess of 51,262 as compared with the first quarter of the previous year. Thus during the six months October, 1934-March, 1935, 123,706 deaths were recorded. If this number is compared with the average (59,354) for these months for the last three years the excess mortality up to the end of March was over 64,000.

Causes of death.—Although the registration of deaths is compulsory throughout Ceylon, the cause of death cannot be accepted as completely accurate since in the rural areas (which contribute 85 per cent. of the total deaths in the Island) the majority of deaths are registered by the headmen of the district and are not medically certified. The urban figures are more reliable as regards cause of death because most of them are based on the certificates of medical practitioners.

Each year the largest number of deaths comes under the heading of " ill-defined " causes forming usually about 15 per cent. of the deaths from all causes. Deaths actually recorded as due to malaria form a very small proportion, only about 1 per cent. of all deaths, but the number of deaths from malaria is probably much understated, and a more accurate index of mortality from this cause is given by combining deaths from malaria and pyrexia. Zymotic causes of deaths are tabulated by month by the Registrar-General and Chart 6 has been drawn to show the seasonal trend for the three largest groups, malaria and pyrexia, respiratory diseases and septic skin conditions based on the average for the 10 years, 1924-33. Deaths from malaria and pyrexia appear to have two seasonal waves, a major one in January and a minor in July. Deaths from skin sepsis* are at their maximum in January while respiratory mortality appears to have a seasonal maximum in July.

(*b*) *Mortality by districts during the epidemic.*—No attempt could be made to study deaths by cause during the months of the epidemic. It is fairly safe to assume that the excess mortality in the districts in the epidemic area was due to the malaria epidemic, but it will be shown that excess mortality was by no means confined to these districts and if the study had been confined only to mortality the picture given of the epidemic would have been somewhat different.

Table 20 shows the deaths registered by months from November to April in the districts in the epidemic area and in those outside that area compared with an " expected " number, the average for four previous years.

The number of deaths began increasing in the epidemic districts in November. In December there was a heavy increase and 13,850 deaths were registered compared with an average of 5,655 for previous years. The peak of mortality occurred in January when there were 27,518 deaths as compared with an average of 6,924; thus the peak of mortality occurred a month later than that of morbidity; it will be remembered that the maximum attendance took place in December. Districts bearing the brunt of the excess mortality were Kurunegala where 24,737 deaths were registered as compared with an average of 5,324; Kegalla with 12,955 deaths against 2,611; Kandy with 16,570 against 6,018; and Matale with 5,972 against 1,660.

In districts outside the epidemic area deaths were slightly above normal in November and December while in January 8,736 deaths were registered as compared with an average of 5,356.

The heavy toll of lives in Kurunegala, Kegalla, Matale and Kandy districts is perhaps more clearly demonstrated in Chart 7 (*a*) and Tables 21 (*a*) and (*b*) which show the mortality by months in the districts in terms of population. The cross-hatched portions on the chart show the average death rate for the corresponding months of 1930-34.

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* Impetigo, ecthyma, &c., are exceedingly common among young ill-nourished children of the poorest classes and in the majority of cases result in death. These deaths are returned by headmen and others under the term " Rathagaya ".

TABLE 20.

" Expected " and Actual Deaths by Months in Districts affected by the Epidemic, November, 1934, to April, 1935.

District.	Population. (1931 Census).	1934. November. *Expected.		December. Expected.		1935. January. Expected.		February. Expected.		March. Expected.		April. Expected.		Total. Expected.		Per Cent. in Excess of Expected.
		Expected.	Actual.	Expected.	Actual.	Expected.	Actual.	Expected.	Actual.	Expected.	Actual.	Expected.	Actual.	Expected.	Actual.	
Colombo ..	875,488	1,481	1,799	1,560	2,732	1,775	3,871	1,480	2,589	1,405	2,178	1,240	1,884	8,941	15,053	(68)
Negombo ..	205,761	274	365	307	613	360	1,221	300	870	260	692	239	540	1,740	4,301	(147)
Kalutara ..	363,785	602	641	610	873	682	1,041	525	659	503	584	422	613	3,344	4,411	(32)
Kandy ..	587,916	1,054	1,265	1,036	2,765	1,239	4,721	968	3,237	898	2,435	823	2,147	6,018	16,570	(175)
Matale ..	129,697	249	425	288	949	369	2,130	262	1,362	247	682	245	424	1,660	5,972	(260)
Kurunegala ..	397,239	762	1,394	827	3,463	1,189	8,924	927	5,095	883	3,384	736	2,477	5,324	24,737	(365)
Chilaw ..	114,640	160	224	172	376	205	749	178	481	166	433	149	332	1,030	2,595	(152)
Ratnapura ..	263,801	479	580	425	996	561	1,426	470	1,313	427	794	382	853	2,744	5,962	(117)
Kegalla ..	314,567	457	595	430	1,083	544	3,435	437	3,560	417	2,494	326	1,788	2,611	12,955	(396)
Totals ..	3,252,894	5,518	7,288	5,655	13,850	6,924	27,518	5,547	19,166	5,206	13,676	4,562	11,058	33,412	92,556	(177)

* Expected deaths are the average for 4 previous years.

" Expected " and Actual Deaths for Districts outside the Epidemic Area.

District.	Population (1931 Census).	1934. November. *Expected.		December. Expected.		1935. January. Expectd.		February. Expected.		March. Expected.		April. Expected.		Totals. Expected.		Per Cent. in excess of Expected.
		Expected.	Actual.	Expected.	Actual.	Expectd.	Actual.	Expected.	Actual.	Expected.	Actual.	Expected.	Actual.	Expected.	Actual.	
Nuwara Eliya ..	235,775	372	466	332	482	484	690	462	510	341	518	350	414	2,341	3,080	(32)
Galle ..	363,553	669	785	662	787	772	1,026	693	868	603	601	508	617	3,907	4,684	(20)
Matara ..	283,292	469	583	438	631	622	990	588	861	433	592	429	556	2,979	4,213	(41)
Hambantota ..	124,359	286	372	298	429	426	932	407	945	316	616	280	553	2,013	3,847	(91)
Jaffna ..	355,425	672	762	749	928	988	1,129	968	974	900	776	780	679	5,057	5,248	(4)
Mannar ..	25,137	59	88	65	107	97	172	114	160	83	89	83	77	501	693	(38)
Mullaittivu ..	18,312	40	59	55	79	72	150	77	132	71	103	58	74	373	597	(60)
Batticaloa ..	174,929	463	395	460	430	443	548	448	479	319	379	385	449	2,518	2,680	(6)T
Trincomalee ..	37,492	88	95	99	113	107	220	102	227	85	170	86	124	567	949	(67)
Puttalam ..	35,087	89	120	103	218	123	291	126	243	122	167	90	130	653	1,169	(79)
Anuradhapura ..	97,365	231	382	309	802	415	1,309	449	1,067	327	655	282	477	2,013	4,692	(133)
Badulla ..	303,243	638	803	644	872	807	1,279	667	927	549	717	497	725	3,802	5,323	(40)
Totals ..	2,053,969	4,076	4,910	4,214	5,878	5,356	8,736	5,101	7,393	4,149	5,383	3,828	4,875	26,724	37,175	(39)

* Expected deaths are the average for 4 previous years.

The peak of mortality occurred in January in all districts except Kegalla where the death rate of February slightly exceeded that of January. Chart 7 (*b*) gives the mortality rates by months in districts outside the epidemic area, and shows the heavy mortality experienced in other areas with the exception of Jaffna., Galle, Batticaloa, and Nuwara Eliya.

So far the study of the epidemic, both for morbidity and mortality has been confined to large areas. It seemed important in view of the extreme severity of the epidemic to make a detailed study of mortality by smaller areas. For administrative purposes each district of Ceylon is divided into divisions known as Chief Headman's divisions. Unpublished data of deaths month by month for these divisions were kindly supplied by the Registrar-General with corresponding figures for previous years. It was thus possible to make a comparison with non-epidemic years.

TABLE 21 (*a*).

Monthly Mortality Rates per 100,000 Population (Census 1931) in Districts affected by the Epidemic.

	Colombo. Mean 1930-34.	Colombo. 1934/35.	Negombo. Mean 1930/34.	Negombo. 1934/35.	Kalutara. Mean 1930/34.	Kalutara. 1934/35.
November	169	205	133	177	165	176
December	178	312	149	298	168	240
January	203	442	175	593	187	286
February	169	296	146	422	144	181
March	160	249	147	336	138	161
April	141	215	116	262	116	169

	Kandy. Mean 1930/34.	Kandy. 1934/35.	Matale. Mean 1930/34.	Matale. 1934/35.	Kurunegala. Mean 1930/34.	Kurunegala. 1934/35.
November	179	215	192	328	192	351
December	176	472	222	732	208	872
January	210	803	285	1,642	299	2,248
February	165	551	202	1,050	233	1,283
March	154	414	190	525	222	852
April	140	365	189	327	185	624

	Chilaw. Mean 1930/34.	Chilaw. 1934/35.	Ratnapura. Mean 1930/34.	Ratnapura. 1934/35.	Kegalla. Mean 1930/34.	Kegalla. 1934/35.
November	140	195	182	220	145	189
December	150	328	161	378	136	344
January	179	653	213	541	173	1,092
February	155	420	178	498	139	1,132
March	145	378	161	301	133	793
April	130	290	145	323	104	568

TABLE 21 (*b*).

Monthly Mortality Rates per 100,000 Population (Census 1931) in Districts outside the Epidemic Area.

	Nuwara Eliya.		Hambantota.		Galle.		Matara.	
	Mean 1930/34.	1934/35.	*Mean 1930/34.*	1934/35.	*Mean 1930/34.*	1934/35.	*Mean 1930/34.*	1934/35.
November	*158*	198	*230*	299	*184*	216	*166*	206
December	*141*	204	*240*	345	*182*	216	*155*	223
January	*205*	293	*343*	749	*212*	282	*220*	349
February	*196*	212	*327*	760	*251*	316	*208*	304
March	*145*	220	*254*	495	*166*	165	*153*	209
April	*148*	176	*225*	445	*140*	170	*151*	196

	Jaffna.		Mannar.		Mullaittivu.		Batticaloa.	
	Mean *1930/34.*	1934/35.	Mean *1930/34.*	1934/35.	Mean *1930/34.*	1934/35.	Mean *1930/34.*	1934/35.
November	*189*	214	*235*	350	*219*	322	*265*	226
December	*211*	261	*259*	426	*301*	432	*263*	245
January	*278*	318	*386*	684	*393*	820	*253*	313
February	*272*	274	*454*	637	*421*	721	*256*	274
March	*218*	218	*330*	354	*388*	563	*182*	217
April	*219*	191	*330*	306	*317*	404	*220*	257

	Trincomalee.		Puttalam.		Anuradhapura.		Badulla.	
	Mean *1930/34.*	1934/35.	Mean *1930/34.*	1934/35.	Mean *1930/34.*	1934/35.	Mean *1930/34.*	1934/35.
November	*235*	253	*254*	342	*237*	392	*210*	265
December	*264*	301	*294*	621	*317*	824	*212*	288
January	*285*	587	*351*	829	*426*	1,344	*266*	422
February	*272*	605	*359*	693	*461*	1,096	*220*	306
March	*227*	453	*348*	476	*336*	673	*181*	236
April	*229*	331	*257*	371	*290*	490	*164*	239

Table 22 sets out the relevant data for the six months November-April and three maps have been constructed to illustrate these data. Map No. 17 shows the distribution of mortality in Chief Headman's divisions for the previous five years 1929-33. Map No. 18 gives the mortality during the six months (November-April) expressed as annual rates of mortality. (It should be noted that the two maps are on different scales owing to the height of the death rates during the epidemic.) Map No. 19 shows the excess mortality during these months as compared with the experience of the last three years.

TABLE 22.

Deaths by Months and Mortality Rate, November, 1934, to April, 1935, in Headman's Division of each District in the Epidemic Area Compared with Average for Three Previous Years.

Division.	Population Census 1931.		1934 November.	December.	1935 January.	February.	March.	April.	Total.	Deaths November to April, expressed as Annual Death Rate per 1,000.	Epidemic Death Rate as Per Cent. of Average.	Average Annual Death Rate 1929 to 1933.
COLOMBO DISTRICT	875,488	*Average for 3 previous years*	*1,441*	*1,517*	*1,790*	*1,528*	*1,497*	*1,266*	*9,039*	*20.6*		
		Epidemic	1,799	2,732	3,869	2,589	2,178	1,884	15,051	34.4	167	20.4
Colombo Municipality	284,155	*Average*	*632*	*679*	*707*	*634*	*690*	*587*	*3,929*	*27.7*		
		Epidemic	774	1,117	1,163	827	779	673	5,333	37.5	136	27.1
Mudaliyar's division	98,367	*Average*	*148*	*134*	*212*	*182*	*170*	*131*	*1,977*	*19.9*		
		Epidemic	186	281	335	209	231	137	1,379	28.0	141	18.8
Alutkuru korale south	86,794	*Average*	*130*	*136*	*176*	*131*	*125*	*123*	*821*	*18.9*		
		Epidemic	217	261	347	301	204	214	1,544	35.6	188	19.9
Hewagam korale	111,859	*Average*	*136*	*127*	*183*	*147*	*120*	*113*	*826*	*14.8*		
		Epidemic	141	303	551	338	251	312	1,896	33.9	230	15.4
Salpiti korale	81,265	*Average*	*131*	*158*	*177*	*143*	*124*	*110*	*843*	*20.7*		
		Epidemic	149	253	275	150	137	128	1,092	26.9	130	20.3
Siyane korale east	76,759	*Average*	*96*	*109*	*127*	*111*	*93*	*76*	*612*	*15.9*		
		Epidemic	127	192	571	384	289	187	1,750	45.6	286	16.1
Siyane korale West	136,289	*Average*	*168*	*174*	*208*	*180*	*157*	*127*	*1,014*	*14.9*		
		Epidemic	205	325	627	380	287	233	2,057	30.2	203	14.6
NEGOMBO DISTRICT	205,761	*Average*	*264*	*305*	*363*	*307*	*273*	*229*	*1,741*	*16.9*		
		Epidemic	365	613	1,223	870	692	540	4,303	41.8	247	16.9
Town	29,474	*Average*	*56*	*79*	*69*	*71*	*71*	*51*	*397*	*26.9*		
		Epidemic	68	134	181	193	150	99	825	56.0	208	29.3
Alutkuru korale north	129,538	*Average*	*153*	*168*	*216*	*172*	*142*	*129*	*980*	*15.1*		
		Epidemic	205	317	618	447	362	311	2,260	34.9	231	14.7
Hapitigam korale	46,749	*Average*	*55*	*58*	*78*	*64*	*60*	*49*	*364*	*15.6*		
		Epidemic	92	162	424	230	180	130	1,218	52.1	335	15.0
KALUTARA DISTRICT	363,785	*Average*	*564*	*578*	*685*	*537*	*500*	*428*	*3,292*	*18.1*		
		Epidemic	641	873	1,041	659	584	613	4,411	24.3	134	18.4
Town	14,280	*Average*	*47*	*52*	*54*	*37*	*36*	*33*	*259*	*36.3*		
		Epidemic	67	89	64	48	45	34	347	48.6	134	35.9
Kalutara totamune	146,039	*Average*	*129*	*131*	*133*	*109*	*110*	*95*	*707*			19.8
		Epidemic	125	165	179	112	97	94	772	19.3	109	
Panadure totamune		*Average*	*126*	*110*	*160*	*113*	*105*	*91*	*705*			
		Epidemic	147	212	239	142	116	100	956	*23.7*	136	
Pasdun korale east	57,084	*Average*	*83*	*76*	*82*	*72*	*69*	*64*	*446*	*15.6*		
		Epidemic	75	100	166	96	85	113	635	22.2	142	15.9
Pasdun korale west	55,195	*Average*	*77*	*77*	*96*	*69*	*67*	*62*	*448*	*16.2*		
		Epidemic	86	89	109	86	104	83	556	20.1	124	17.0
Raigam korale	91,187	*Average*	*102*	*132*	*160*	*137*	*113*	*83*	*727*	*15.9*		
		Epidemic	141	218	284	175	137	189	1,144	25.1	157	16.0

TABLE 22—*continued.*

Division.	Population Census, 1931.		1934 November.	December.	1935 January.	February.	March.	April.	Total.	Deaths November to April, expressed as Annual Death Rate per 1,000.	Epidemic Death Rate as Per Cent. of Average.	Average Annual Death Rate 1929 to 1933.
KANDY DISTRICT	587,916	*Average*	*1,136*	*1,021*	*1,213*	*974*	*914*	*853*	*6,085*	*20.7*		
		Epidemic	1,265	2,765	4,721	3,237	2,435	2,147	26,570	90.4	437	21.2
Municipality	37,147	*Average*	*97*	101	*99*	*82*	*87*	*88*	*554*	*29.8*		
		Epidemic	120	321	386	378	260	259	1,724	92.8	311	31.4
Haris pattu	58,748	*Average*	*100*	*101*	*112*	*105*	*90*	*72*	*580*	*19.7*		
		Epidemic	121	552	810	399	277	244	2,403	81.8	414	18.7
Pata Dumbara	86,643	*Average*	*149*	*165*	*193*	*153*	*149*	*125*	*934*	*21.6*		
		Epidemic	217	565	883	562	423	323	2,973	68.6	318	22.9
Pata Hewaheta	43,797	*Average*	*70*	*65*	*89*	*77*	*60*	*73*	*434*	*19.8*		
		Epidemic	86	200	274	205	159	144	1,068	48.8	246	19.9
Tumpane	21,403	*Average*	*37*	*35*	*44*	*40*	*34*	*24*	*214*	*20.0*		
		Epidemic	58	162	782	567	244	168	1,981	185.1	926	19.4
Uda Bulatgama	138,878	*Average*	*235*	*193*	*271*	*191*	*208*	*199*	*1,297*	*18.7*		
		Epidemic	279	227	385	371	374	303	1,939	27.9	149	20.7
Uda Dumbara	37,437	*Average*	*79*	*90*	*101*	*72*	*54*	*64*	*460*	24.6		
		Epidemic	134	210	386	185	146	111	1,172	62.6	255	25.5
Udunuwara	30,317	*Average*	*44*	*50*	*56*	*45*	*54*	*41*	*290*	*19.1*		
		Epidemic	40	164	214	132	112	118	780	51.5	269	17.5
Udapalata	89,650	*Average*	*160*	*148*	*164*	*144*	*128*	*110*	*854*	*19.1*		
		Epidemic	151	189	366	270	310	321	1,607	35.9	188	20.0
Yatinuwara	43,896	*Average*	*59*	*73*	*84*	*65*	*50*	*57*	*388*	*17.7*		
		Epidemic	59	175	235	168	130	156	943	43.0	243	17.0
MATALE DISTRICT	129,697	*Average*	*233*	*274*	*391*	*260*	*247*	*239*	*1,644*	*25.4*		
		Epidemic	425	949	2,130	1,362	682	424	5,972	92.1	363	27.5
Town	10,415	*Average*	*32*	*35*	*35*	*34*	*35*	*32*	*203*	*39.0*		
		Epidemic	87	158	147	139	102	71	704	135.2	347	44.7
Matale South	60,727	*Average*	*79*	*85*	*132*	*82*	*91*	*101*	*570*	*18.8*		
		Epidemic	164	324	810	554	294	173	2,319	76.4	407	21.8
Matale East	32,504	*Average*	*63*	*67*	*120*	*57*	*54*	*47*	*408*	*25.1*		
		Epidemic	90	186	421	228	119	58	1,102	67.8	270	26.3
Matale North	26,051	*Average*	*59*	*87*	*104*	*87*	*67*	*60*	*464*	*35.6*		
		Epidemic	84	281	752	441	167	122	1,847	141.8	398	35.6
NUWARA ELIYA DISTRICT	235,755	*Average*	*357*	*328*	*500*	*485*	*332*	*370*	*2,372*	*20.1*		
		Epidemic	466	482	690	510	518	414	3,080	26.2	130	20.5
Town	7,823	*Average*	*24*	*18*	*24*	*19*	*16*	*21*	*122*	*31.2*		
		Epidemic	13	23	35	29	31	24	155	39.6	127	30.8
Gravets	20,679	*Average*	*35*	*18*	*51*	*34*	*20*	*30*	*188*	*18.2*		
		Epidemic	34	20	39	34	43	23	193	18.7	103	18.4
Kotmale	127,881	*Average*	*157*	*146*	*232*	*262*	*181*	*199*	*1,177*	*18.4*		
		Epidemic	221	192	317	232	247	189	1,398	21.9	119	19.4
Udahewaheta	44,444	*Average*	*70*	*78*	*103*	*88*	*56*	*63*	*458*	*20.6*		
		Epidemic	92	155	188	138	106	94	773	34.8	169	20.0
Walapane	34,948	*Average*	*71*	*68*	*90*	*82*	*59*	*57*	*427*	*24.4*		
		Epidemic	106	92	111	77	91	84	561	32.1	131	23.8
KURUNEGALA DISTRICT	397,239	*Average*	*756*	*795*	*1,137*	*892*	*842*	*725*	*5,147*	*25.9*		
		Epidemic	1,394	3,463	8,925	5,095	3,384	2,477	24,738	124.6	481	27.2
Town	10,467	*Average*	*43*	*59*	*63*	*41*	*46*	*50*	*302*	*57.7*		
		Epidemic	108	284	368	313	275	169	1,517	289.9	502	62.9
Hiriyala hatpattu	40,586	*Average*	*110*	*94*	*171*	*125*	*113*	*103*	*716*	*35.0*		
		Epidemic	138	369	1,054	524	254	198	2,537	124.2	354	35.0
Weudawilli hatpattu	71,409	*Average*	*133*	*133*	*216*	*137*	*127*	*124*	*870*	*24.4*		
		Epidemic	293	822	2,051	1,397	899	543	6,005	168.2	690	27.0
Dambadeni hatpattu	75,561	*Average*	*132*	*133*	*156*	*127*	*121*	*101*	*770*	*20.4*		
		Epidemic	384	907	1,995	952	676	438	5,352	141.7	695	21.8
Dewamedi hatpattu	47,481	*Average*	*98*	*103*	*137*	*124*	*123*	*91*	*676*	*28.5*		
		Epidemic	132	352	1,192	558	311	298	2,843	119.8	421	30.6
Katugampola hatpattu	109,664	*Average*	*141*	*160*	*219*	*178*	*176*	*140*	*1,014*	*18.5*		
		Epidemic	212	412	1,705	987	755	612	4,683	85.4	462	19.0
Wanni hatpattu	41,801	*Average*	*99*	*113*	*175*	*160*	*136*	*117*	*800*	*38.3*		
		Epidemic	127	317	560	364	214	219	1,801	86.2	225	38.2
CHILAW DISTRICT	114,640	*Average*	*158*	*196*	*204*	*180*	*166*	*153*	*1,057*	*18.4*		
		Epidemic	224	376	749	481	433	332	2,595	45.3	246	18.1
Town	7,203	*Average*	*22*	*29*	*26*	*28*	*28*	*25*	*158*	*43.9*		
		Epidemic	32	58	98	81	99	73	441	122.4	279	43.5
Pitigal korale north	32,027	*Average*	*46*	*50*	*56*	*48*	*48*	*50*	*298*	*18.6*		
		Epidemic	66	138	245	145	110	98	802	50.1	269	19.2
Pitigal korale south	75,410	*Average*	*90*	*117*	*122*	*104*	*90*	*78*	*601*	*15.9*		
		Epidemic	126	180	406	255	224	161	1,352	35.9	225	15.2
RATNAPURA DISTRICT	263,801	*Average*	*440*	*410*	*531*	*461*	*410*	*370*	*2,622*	*19.9*		
		Epidemic	580	996	1,426	1,313	794	853	5,962	45.2	227	22.9
Town	8,497	*Average*	*35*	*30*	*26*	*27*	*25*	*23*	*166*	*39.1*		
		Epidemic	35	61	54	71	48	69	338	79.6	204	42.5
Kuruwiti korale	57,119	*Average*	*70*	*75*	*80*	*74*	*71*	*59*	*429*	*15.0*		
		Epidemic	100	180	263	232	170	205	1,150	40.3	268	15.9
Nawadun korale	69,070	*Average*	*94*	*84*	*113*	*98*	*79*	*79*	*547*	*15.8*		
		Epidemic	119	170	247	148	121	169	974	28.2	178	18.3
Atakalan korale	40,613	*Average*	*81*	*77*	*119*	*87*	*96*	*65*	*525*	*25.9*		
		Epidemic	96	201	368	322	190	165	1,342	66.1	256	32.1
Kadawata korale	28,080	*Average*	*57*	*49*	*66*	*62*	*45*	*49*	*328*	*23.4*		
		Epidemic	78	136	164	151	72	60	661	47.1	202	24.9
Kolonne korale	15,517	*Average*	*34*	*35*	*38*	*38*	*34*	*31*	*210*	*27.1*		
		Epidemic	50	76	95	173	84	71	549	70.8	261	30.8
Kukulu korale	17,733	*Average*	*20*	*22*	*28*	*20*	*19*	*21*	*130*	*14.7*		
		Epidemic	34	56	49	58	27	49	273	30.8	210	16.9
Meda korale	27,172	*Average*	*49*	*38*	*61*	*55*	*41*	*42*	*286*	*21.1*		
		Epidemic	68	116	186	158	82	65	675	49.7	236	26.5
KEGALLA DISTRICT	314,567	*Average*	*434*	*394*	*520*	*433*	*418*	*354*	*2,553*	*16.2*		
		Epidemic	595	1,083	3,435	3,560	2,494	1,788	12,955	82.4	507	17.1
Town	3,711	*Average*	*25*	*31*	*22*	*19*	*19*	*15*	*131*	*70.6*		
		Epidemic	39	84	133	161	169	100	686	369.7	524	77.6
Paranakuru korale	50,804	*Average*	*80*	*76*	*96*	*88*	*61*	*62*	*463*	*18.2*		
		Epidemic	85	245	727	632	435	377	2,501	98.5	540	18.4
Beligal korale	74,313	*Average*	*93*	*91*	*124*	*92*	*95*	*77*	*572*	*15.4*		
		Epidemic	168	299	938	742	469	275	2,891	77.8	505	15.1
Galboda korale	37,078	*Average*	*55*	*42*	*74*	*51*	*55*	*48*	*325*	*17.5*		
		Epidemic	59	112	617	727	442	360	2,317	125.0	713	17.6
Kinigoda korale	28,572	*Average*	*44*	*34*	*53*	*41*	*31*	*34*	*237*	*16.6*		
		Epidemic	70	181	542	600	377	195	1,965	137.6	829	18.7
Dehigampal korale	35,901	*Average*	*58*	*39*	*52*	*58*	*59*	*41*	*307*	*17.1*		
		Epidemic	71	58	185	240	235	222	1,011	66.3	329	18.2
Atulugam korale	35,839	*Average*	*35*	*31*	*37*	*36*	*42*	*31*	*213*	*11.9*		
		Epidemic	43	51	132	188	145	127	686	38.3	322	12.8
Panawal korale	18,135	*Average*	*15*	*15*	*18*	*19*	*16*	*16*	*99*	*10.9*		
		Epidemic	19	22	62	94	62	63	322	35.5	325	13.1
Lower Bulatgama	30,214	*Average*	*29*	*35*	*44*	*29*	*39*	*30*	*206*	*13.6*		
		Epidemic	41	31	99	176	160	69	576	38.1	280	16.1

The normal favourable condition of the wet zone area as regards mortality will be seen from Map No. 17. Most of the area had a mortality rate of less than 20 per 1,000. The dry zones, particularly those areas lying in the extreme south-east, in the northern part of Anuradhapura District, and the whole of Mannar had much heavier rates of mortality.

Map No. 18 presents a different picture. The epidemic area has been outlined and the concentration of severe mortality over the divisions of Kegalla, Kurunegala, Kandy and Matale Districts is clearly demonstrated. But the most striking features of the map are the extent of the black portion (which indicates a mortality rate of over 80 per 1,000) north of the epidemic area, comprising Anuradhapura and Mannar and the very high, though less severe, mortality in Mullaittivu, Trincomalee and Puttalam.

That mortality is normally excessive in parts of Anuradhapura District and in the whole of Mannar District has been shown in Map No. 17. Both districts are very sparsely populated, only a small portion of these districts is cultivated and the people are in a continual state of ill-health through malarial infections and lack of food. Vitality is at a low ebb and the margin between life and death must be very narrow. Year by year the deaths exceed the births, infant mortality in Mannar is over 300 per 1,000 births, and the population is only maintained by immigration. In a description of the conditions of the people in the North and North-Central Provinces, Carter (1927 p. 8) writes " Life in these villages is often a prolonged struggle for existence, the severity of which depends largely upon the conditions of the village tank. If the tank be small or in poor repair it may, comparatively soon after the rains have ceased, dry out completely or retain water merely in a series of muddy pools alongside the bund. In such cases the village crop of paddy is likely to be seriously jeopardized or lost, and the lot of the inhabitants during the ensuing months may be one of great hardships. In such circumstances, it is scarcely surprising that many of the villages in the interior of the dry zone are poverty stricken, that malaria and other diseases are prevalent, and that the inhabitants are often too lethargic and enervated to attempt to modify existing conditions or even to afford themselves adequate protection from the rains and winds of the monsoons ".

The general welfare of the whole Island was affected by the economic depression and the drought of 1934 brought increased privations. The inhabitants of the endemic areas are accustomed to sickness and some increased privations might easily occur and be borne without special complaint but the effect would be reflected in the death rates. In actual numbers 4,692 deaths were registered in Anuradhapura District compared with an average of 2,013 for the last four years. But this District was suffering from drought and in receipt of relief on account of food shortage three months before the epidemic started. Mannar had 693 deaths against an average of 501. Mullaittivu had 597 deaths compared with 373.

A clearer impression of the relative excess of mortality during the six months November-April may be obtained from a study of Map No. 19 in which the death rates have been expressed as percentages of the average for four previous years. This map tells its own story and needs little comment here.

(c) *Age Distribution of Deaths.**—During normal times the death rate in Ceylon is highest at the extremes of life, though, owing to the heavy infant death rate, mortality under five years usually exceeds that over fifty-five years. During the decade 1923-32, 46 per cent. of the total deaths were of children under five years and the death rate for this age group was 78.5 per 1,000. In the age period over fifty-five years the death rate was 67.5 per 1,000. Infant deaths under one year formed 60 per cent. of all deaths at the age period under 5 and 28 per cent. of deaths at all ages and the infant death rate was 176 per 1,000 births.

A special feature of the mortality during the epidemic was the heavy toll of life among young children. Deaths of infants in the epidemic districts amounted to 355 per 1,000 births during the last quarter of 1934 and the first quarter of 1935. In Kurunegala District as many as 800 infants died out of every 1,000 births, in Matale District the infant mortality was nearly 500 per 1,000 births and in Kegalla District the figure was 452. The infant mortality rates for epidemic and non-epidemic districts are shown in Table 23. In Puttalam and Anuradhapura Districts outside the epidemic area, infant mortality is usually excessive but during the period studied the death rate of infants reached the high rate of 613 per 1,000 births in Anuradhapura and 512 in Puttalam. How far any of the figures in Table 23 are affected by errors in birth registration during the height of the epidemic cannot be ascertained.

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* Deaths in each district classified by age were kindly supplied by the Registrar-General for the last quarter of 1934 and for the first quarter of 1935 together with corresponding figures for three previous years. The populations of ages for each district were obtained by assuming the population at the census of 1931 was distributed at ages in the same proportion as at the census of 1921. Such estimation obviously involves a certain amount of error.

TABLE 23.

Infant Deaths per 1,000 Births during the Last Quarter of 1934 and First Quarter of 1935 (combined).

Epidemic Districts.

Districts.	Births.	Infant Deaths under 1 Year.	Death Rate per 1,000 Births.	*Infant Mortality Average, 1923–32.*
Colombo	15,244	2,994	196.4	*148*
Negombo	3,625	977	269.5	*135*
Kalutara	6,685	862	128.9	*117*
Kandy	12,420	3,855	310.4	*184*
Matale	3,056	1,519	497.1	*216*
Kurunegala	10,264	8,210	799.9	*233*
Chilaw	2,082	648	311.2	*159*
Ratnapura	6,125	1,426	232.8	*161*
Kegalla	6,765	3,059	452.2	*138*
Total	66,266	23,550	355.4	*165*

Non-epidemic Districts.

Districts.	Births.	Infant Deaths under 1 Year.	Rate per 1,000 Births.	*Infant Mortality Average, 1923–32.*
Nuwara Eliya	5,194	1,013	195.0	*205*
Galle	8,048	1,095	136.1	*132*
Matara	7,082	1,008	142.3	*132*
Hambantota	3,526	1,096	310.8	*222*
Jaffna	6,371	1,420	222.9	*188*
Mannar	523	227	434.0	*374*
Mullaittivu	409	194	474.3	*318*
Batticaloa	3,753	787	209.7	*235*
Trincomalee	996	284	285.1	*261*
Puttalam	771	395	512.3	*342*
Anuradhapura	2,682	1,644	613.0	*309*
Badulla	7,731	1,579	204.2	*197*
Total	47,086	10,742	228.1	*191*

During the first quarter of 1935 when mortality was at its highest the death rate of children under five years in the epidemic districts amounted to 278 per 1,000, but the rate recorded in some of the districts greatly exceeded this figure. For example in Kurunegala the death rate under five years was 844 per 1,000, in Matale 513 per 1,000 and in Kegalla 398 per 1,000.

In the epidemic districts as a whole deaths under five years normally form about 46 per cent. of all deaths but during the worst period of the epidemic this proportion increased to 54 per cent. In Kurunegala, Matale and Kegalla Districts the deaths under five years tend normally to be high, forming about 50 per cent. of all deaths, but during the epidemic the proportion increased to 67 per cent., 57 per cent., and 56 per cent. respectively.

Districts outside the epidemic area appear normally to have a slightly higher proportion of deaths at ages under five years, 48 per cent. During the first quarter of 1935, this proportion increased to 52 per cent. probably due to the very high infant death rate already referred to in certain districts. In two districts, Hambantota and Anuradhapura, where deaths under five years usually form 50 per cent. of all deaths, the proportions increased to 61 per cent. and 60 per cent. respectively, while in Puttalam there was an increase from 44 per cent. to 58 per cent.

Distribution of Deaths at Ages during the First Quarter of 1935.

Ages.	Epidemic Districts.				Non-Epidemic Districts.			
	Average, 1931–33.	*% of all Ages.*	Epidemic.	% of all Ages.	*Average, 1931–33.*	*% of all Ages.*	Epidemic.	% of all Ages.
0– 5	*8,087*	*45.9*	32,258	53.5	*7,100*	*48.1*	11,118	51.7
5–10	*727*	*4.1*	3,963	6.6	*651*	*4.4*	1,002	4.7
10–15	*310*	*1.8*	1,229	2.0	*285*	*1.9*	349	1.6
15–25	*1,147*	*6.5*	3,169	5.2	*983*	*6.7*	1,315	6.1
25–45	*2,632*	*14.9*	6,881	11.4	*2,087*	*14.2*	2,891	13.4
45 and over	*4,715*	*26.8*	12,863	21.3	*3,651*	*24.7*	4,834	22.5
Unknown	—	—	4	—	—	—	—	—
All ages	*17,618*	*100*	60,367	100	*14,757*	*100*	21,509	100

It is of special interest to know whether, at the commencement of the epidemic, the increase of mortality was confined to any particular age group. It has already been shown that mortality began rising in the epidemic area in November and there was a heavy increase in December. It will be seen from the figures given below that, during the last quarter of 1934, although in actual numbers the deaths were excessive in the under five years age group, the greatest relative increase was in the 5-10 age group even in the early months of the epidemic. With regard to infant deaths the proportion of deaths under one year was 26.7 per cent. in the last quarter of 1934 and 27.3 per cent. in the first quarter of 1935.

Distribution of Deaths at Ages in the Epidemic Districts during the Last Quarter of 1934 and First Quarter of 1935.

Age.	*Average No. of Deaths, 4th Quarters, 1931–33.*	Deaths during Epidemic, 4th Quarter, 1934.	% Epidemic of Average at each Age.	*Average No. of Deaths, 1st Quarters, 1931–33*	Deaths during Epidemic, 1st Quarter, 1935.	% Epidemic of Average at each Age.
Under 5 years	*7,800*	12,627	162	*8,087*	32,258	399
5–10 years	*707*	1,668	236	*727*	3,963	545
10–15 years	*284*	597	210	*310*	1,229	396
15–25 years	*1,005*	1,647	164	*1,147*	3,169	276
25–45 years	*2,243*	3,388	151	*2,632*	6,881	261
45 and over	*4,202*	6,712	160	*4,715*	12,863	273
Age unknown	—	—	—	—	4	—
All ages	*16,241*	26,639	164	*17,618*	60,367	343

The figures given in the next table summarize the mortality at ages in terms of population (expressed as annual death rates) in the epidemic and non-epidemic districts for the first quarter of 1935. The most interesting feature of the study of the age distribution of mortality is that although *absolutely* there was a heavy concentration of mortality under five years of age, *relatively* the greatest increase in the epidemic districts was at ages 5-10 years where the death rate rose to nearly five and half times the average. The figures also clearly demonstrate that although excess mortality in the epidemic area varied in degree at particular age periods, it was not confined to any one age group.

Death Rates per 10,000 Population.

Age.	Epidemic Districts.			Non-Epidemic Districts.		
	Average First Quarters, 1931–33.	Epidemic First Quarter 1935.	% Epidemic of Average at each Age.	*Average First Quarters, 1931–33.*	Epidemic First Quarter, 1935.	% Epidemic of Average at each Age.
Under 5 years	*698*	2,782	399	*952*	1,490	157
5–10 years	*70*	381	544	*100*	153	153
10–15 years	*31*	124	400	*44*	54	123
15–25 years	*72*	199	276	*106*	142	139
25–45 years	*115*	302	263	*145*	201	134
45 and over	*440*	1,201	273	*501*	663	132
Age unknown	—	—	—	—	—	—
All ages	*217*	742	342	*287*	419	146

In the non-epidemic districts as a whole, where normally mortality is higher at every age than in the epidemic districts, there was also a general rise in the death rate but at no age period was the rise greater than 157 per cent. of the average. For example, mortality was 57 per cent. in excess of the average at ages under five years as against 299 per cent. in the epidemic districts while at ages 10-15 the corresponding figures were 23 per cent and 300 per cent.

Table 24 (*a*) shows in detail how greatly the relative increase in the death rate varied at different ages in the epidemic districts. The greater relative increase at ages 5-15 years was very pronounced for the Kandy, Kegalla and Matale Districts. Kurunegala was the only district where the excess was both absolutely and relatively greater at ages under five years. A special feature of the Kegalla mortality was the heavy relative increase at every age as compared with other districts.

Table 24 (*b*) gives the corresponding figures for the non-epidemic districts.

TABLE 24 (*a*).

Death Rates at Ages per 10,000 Population. Fourth Quarter, 1934, and First Quarter, 1935 (combined).

Epidemic Districts.

District.		Under 5 Years.	5–15 Years.	15–25 Years.	25–45 Years.	45 Years and Over.	All Ages.
Colombo and Negombo	*Average*	*641.8*	*39.7*	*67.1*	*114.2*	*454.3*	*203.2*
	Epidemic	994.8	100.3	115.8	204.1	788.6	346.8
	% epidemic of average	155	253	173	179	174	171
Kalutara	*Average*	*542.0*	*55.6*	*55.3*	*88.3*	*382.7*	*185.1*
	Epidemic	601.0	89.8	77.4	126.7	544.7	241.2
	% epidemic of average	111	162	140	143	142	130
Kandy	*Average*	*736.5*	*54.9*	*63.9*	*97.5*	*386.6*	*210.0*
	Epidemic	1718.9	240.1	178.2	228.3	920.9	526.8
	% epidemic of average	222	437	279	234	238	251
Matale	*Average*	*886.4*	*76.8*	*80.7*	*128.1*	*452.0*	*250.9*
	Epidemic	3533.7	384.0	233.3	329.4	1268.2	891.6
	% epidemic of average	399	500	209	257	281	355
Kurunegala	*Average*	*966.0*	*57.6*	*98.8*	*148.5*	*481.2*	*263.4*
	Epidemic	5553.1	137.1	231.1	346.6	1654.7	1159.4
	% epidemic of average	575	238	234	233	344	440
Chilaw	*Average*	*581.5*	*38.2*	*54.2*	*100.3*	*409.8*	*178.1*
	Epidemic	1465.8	105.3	133.8	211.5	812.3	418.7
	% epidemic of average	252	276	247	211	213	235
Ratnapura	*Average*	*720.2*	*66.4*	*64.7*	*95.4*	*354.4*	*215.6*
	Epidemic	1316.3	172.2	122.7	181.4	737.1	420.0
	% epidemic of average	183	259	190	190	208	195
Kegalla	*Average*	*501.9*	*42.6*	*48.1*	*67.0*	*341.3*	*165.8*
	Epidemic	2414.9	337.6	201.3	231.3	1163.2	739.6
	% epidemic of average	481	792	419	345	341	446

TABLE 24 (*b*).

Death Rates at Ages per 10,000 Population. Fourth Quarter, 1934, and First Quarter, 1935 (combined).

Non-epidemic Districts.

District.		Under 5 Years.	5–15 Years.	15–25 Years.	25–45 Years.	45 Years and Over.	All Ages
Nuwara Eliya	*Average*	*772.8*	*48.3*	*56.6*	*78.5*	*356.6*	*200.6*
	Epidemic	934.3	69.3	87.6	118.1	477.3	262.0
	% epidemic of average	121	143	155	150	134	131
Galle	*Average*	*668.1*	*52.1*	*66.1*	*95.9*	*402.0*	*217.8*
	Epidemic	762.6	77.2	81.2	117.1	482.4	260.2
	% epidemic of average	114	148	123	122	120	119
Matara	*Average*	*627.5*	*58.5*	*63.5*	*94.1*	*375.0*	*213.1*
	Epidemic	863.9	101.0	91.9	121.1	506.1	343.5
	% epidemic of average	138	173	145	129	135	161
Hambantota	*Average*	*1017.2*	*108.1*	*124.8*	*206.7*	*585.5*	*339.2*
	Epidemic	2105.7	188.5	147.4	275.2	859.1	588.5
	% epidemic of average	207	174	118	133	147	173
Jaffna	*Average*	*950.9*	*68.3*	*107.7*	*137.4*	*474.8*	*272.9*
	Epidemic	1076.3	56.7	110.6	133.0	544.3	296.8
	% epidemic of average	113	83	103	97	115	109
Mannar	*Average*	*1552.6*	*71.4*	*178.5*	*215.0*	*601.2*	*366.8*
	Epidemic	2608.0	114.2	197.9	320.2	789.9	550.9
	% epidemic of average	168	160	111	149	131	150
Mullaittivu	*Average*	*1341.0*	*110.2*	*176.0*	*232.0*	*546.1*	*370.2*
	Epidemic	2735.3	124.6	295.0	349.8	761.3	623.6
	% epidemic of average	204	113	168	151	139	168
Batticaloa	*Average*	*1036.9*	*78.2*	*91.0*	*157.4*	*549.8*	*306.2*
	Epidemic	889.5	63.1	103.6	210.7	624.7	303.6
	% epidemic of average	86	81	114	134	114	99
Trincomalee	*Average*	*988.4*	*68.1*	*113.2*	*155.1*	*434.7*	*283.3*
	Epidemic	1861.2	111.2	175.1	238.1	683.7	488.1
	% epidemic of average	188	163	155	154	157	172
Puttalam	*Average*	*1449.5*	*81.6*	*174.8*	*200.9*	*646.1*	*353.4*
	Epidemic	3376.8	146.4	220.4	266.1	926.4	635.6
	% epidemic of average	233	179	126	132	143	180
Anuradhapura	*Average*	*1536.7*	*99.1*	*205.4*	*235.2*	*642.6*	*399.1*
	Epidemic	4712.6	167.0	314.7	383.6	1171.0	923.1
	% epidemic of average	307	169	153	163	182	231
Badulla	*Average*	*862.6*	*70.5*	*165.1*	*130.0*	*459.3*	*254.4*
	Epidemic	1210.6	105.5	126.9	172.3	580.6	350.9
	% epidemic of average	140	150	77	133	126	138

SECTION IV.

CLINICAL.

1. **The Malarial Parasite.**

Reports from nine laboratories (Table 25) of the number of blood films positive for the three species of malaria have been analysed. The number of these positive films is 12,334, and the returns for each species are:—

	Number.	Percentage.
P.vivax	7,679	62.2
P.falciparum	4,524	36.7
P.malariae	131	1.1

The summary of the returns is given in the following table:—

	Total Positive.	*P.vivax.*	*P.falci.*	*P.mal.*	% *P.vivax.*	% *P.falci.*	% *P.mal.*
November	748	540	185	23	72.2	24.7	3.1
December	2,895	1,981	899	15	68.4	31.1	0.5
January	2,940	1,618	1,276	46	55.0	43.4	1.6
February	3,462	1,942	1,491	29	56.1	43.1	0.8
March	2,129	1,517	596	16	71.2	28.0	0.8

Accuracy of the Reports.—The diagnosis of the species of the malarial parasite does not present much difficulty when the films contain many parasites which have developed beyond the ring stage, but the diagnosis may not be made with any great assurance for films which show only a few early ring forms. Therefore it is important that facts should be given which throw doubt on the accuracy of the returns which have been summarized in Table 25; and also any facts which may reconcile apparently discordant results.

TABLE 25.

Summary of the Returns of Blood Films Positive for Malaria giving the Number for Each Species.

(November, 1934, to March, 1935).

	[1]Anuradhapura.			[1]Badulla.			[2]Galle.			[3]Kandy.			[3]Kurunegala.			[4]Ratnapura.			Pathologist, General Hospital, Colombo.			Superintendent, Anti-malaria Campaign									Bacteriological Institute.		
																						General Hospital, Colombo.			Children in Schools.			Outstations all altitudes.					
	P. vivax.	P. falciparum.	P. malariae.	P. vivax.	P. falciparum.	P. malariae.	P. vivax.	P. falciparum	P. malariae.	P. vivax.	P. falciparum.	P. malariae.	P. vivax.	P. falciparum.	P. malariae.	P. vivax.	P. falciparum.	P. malariae.	P. vivax.	P. falciparum.	P. malariae.	P. vivax.	P. falciparum.	P. malariae.	P. vivax.	P. falciparum	P. malariae.	P. vivax.	P. falciparum.	P. malariae.	P. vivax.	P. falciparum.	P. malariae.
November, 1934	80	88	14	50	3	7	10	0	1	211	48	0	147	11	1	8	1	0	34	34	0												
December, 1934	93	93	5	44	0	7	79	8	0	1096	171	0	90	24	1	143	10	0	212	525	0							224	68	2			
January, 1935	75	135	0	50	1	2	56	64	3	498	332	0	33	11	1	173	17	0	273	549	0	211	70	30	15	6	0	234	91	10	81	77	2
February, 1935	35	128	0	30	6	7	61	31	5	638	460	0	115	69	1	201	11	0	314	611	0	171	51	13	178	58	2	199	66	1			
March, 1935	16	39	0	21	0	5	53	4	1	492	170	0	93	26	0	105	6	1	319	244	4	169	28	3				165	37	2	84	42	0
Totals	299	483	19	195	10	28	259	107	10	2935	1181	0	478	141	4	630	45	1	1152	1963	4	551	149	46	193	64	2	822	262	15	165	119	2
Total Positive		801			233			376			4116			623			676			3119			746			259			1099			286	
Grand Total 12,334																	*Percentages.*																
November, 1934	44.0	48.4	7.7	83.3	5	11.7	90.9	0	9.1	81.5	18.5	0	92.5	6.9	0.6	88.9	11.1	0	50.0	50.0	0												
December, 1934	48.7	48.7	2.6	86.3	0	13.7	90.8	9.2	0	86.5	13.5	0	78.3	20.9	0.9	93.5	6.5	0	28.8	71.2	0							76.2	23.1	0.7			
January, 1935	35.7	64.3	0	94.3	1.9	3.8	45.5	52.0	2.4	60.0	40.0	0	73.3	24.4	2.2	91.1	8.9	0	33.2	66.8	0	67.8	22.5	9.6	71.4	28.6	0	69.9	27.2	3.0	50.6	48.1	1.3
February, 1935	21.5	78.5	0	69.8	14.0	16.3	62.9	32.0	5.2	58.1	41.9	0	62.2	37.3	0.5	94.8	5.2	0	33.9	66.1	0	72.8	21.7	5.5	74.8	24.4	0.8	74.8	24.8	0.4			
March, 1935	29.1	70.9	0	80.8	0	19.2	91.4	6.9	1.7	74.3	25.7	0	78.2	21.8	0	93.7	5.4	0.9	56.3	43.0	0.7	84.5	14.0	1.5				80.9	18.1	1.0	66.7	33.3	0
Total	37.3	60.3	2.4	83.7	4.3	12.0	68.9	28.5	2.7	71.3	28.7	0	76.7	22.6	0.6	93.2	6.7	0.1	36.9	62.9	0.1	73.9	20.0	6.2	74.5	24.7	0.8	74.8	23.8	1.4	57.7	41.6	0.7

[1] Highly endemic, outside epidemic area.

[2] Comparatively non-malarious area.

[3] Epidemic area.

[4] Slightly endemic area outside epidemic area.

The examinations of the films from the Colombo hospitals were done under the supervision of highly qualified experts; and the senior assistants working under them are men who have had years of experience. But the Laboratory Assistants in the outstations (Anuradhapura, Badulla, Galle, Kandy, Kurunegala and Ratnapura) have only been trained to make more or less simple laboratory determinations and were not working under the direct supervision of experts.

The reports show that the proportion of negative to positive films examined at all laboratories was as five is to two; that is:—approximately 30,000 films had been examined during the epidemic to the end of March. The average length of time occupied on each film has not been stated, but one example among others, which can be given, will serve to show that this has in some laboratories been very short indeed.

The following gives the number of examinations which were made in the small Kandy laboratory during the month of February:—

Urine analyses	1,432
Faeces for ova, amoebae, &c.	809
Blood films	1,934
Other examinations	363
Total	4,538

Two assistants were working in the laboratory during February, and the senior claims to have done all the urine analyses and the examination of the blood films; and now, however well the work may have been organized, it is certain that not more than two or three minutes could have been spent on each film.

All returns give a definite species diagnosis for every film examined, and this appears to be usual practice, not only in Ceylon, but in most other countries; but it is certain that a definite diagnosis cannot be made for many films which contain only one or two ring forms.

The returns for the Colombo General Hospital have come from two laboratories; the pathologist and his assistants examined 2,574 films and found 32.7 per cent. tertian, 67.2 per cent. subtertian, but not a single quartan parasite; the Superintendent, Anti-malaria Campaigns, and his assistants examined 546 films and found 69.9 per cent. tertian, 22.1 per cent. subtertian and 7.8 per cent. quartan.

These results appear at variance, but possibly a partial explanation may be that the films examined by the pathologist were from in-patients, whereas the Superintendent, Anti-malaria Campaigns examined films from out-patients; and during this time the General Hospital was overcrowded and only patients who were seriously ill were admitted, and undoubtedly subtertian malaria more often produces acute symptoms than tertian malaria, and hence a high percentage of the former is to be expected among the in-patients.

Knowles and Senior White (1930) described several interesting tests of the reliability of students and others in diagnosing the three species of malarial parasites; and the percentage of accuracy ranged from 43 per cent. for students examining a single cell to 93 per cent. for experts spending five minutes over each slide, the latter were all highly experienced and included professors of protozoology and pathology.

Fifty slides were examined at the Kandy laboratory and the Bacteriological Institute and the percentage of disagreement was twelve. Another fifty slides were examined in the latter laboratory and at the pathologist's laboratory and the percentage of disagreement was six.

When these facts are taken into consideration it is certain that the species diagnosis made during this epidemic are not very accurate.

Gametocytes.—The pathologist of the Colombo General Hospital has kept records of the number of occasions on which tertian gametocytes and subtertian crescents were seen in the films examined in his laboratory and the following are the results:—

	Total slides positive for Parasites.	Tertian Gametocytes.	Crescents.	Percentage.
November	68	1	1	2.9
December	737	4	68	9.8
January	822	30	133	19.8
February	925	47	292	36.6

Quartan Malaria.—Carter (1927) gives a table showing the proportional distribution of malarial parasites as found in films examined in his department. The final totals for the 1,751 positive films were: tertian 57.7, quartan 33.7, and subtertian 10.1.

These films were taken from both children and adults and included a considerable number from hospital and dispensary patients.

This distribution is very different from that which has been found in the present epidemic; and it may be that the prevalence of quartan has been markedly affected by the prevalence of the other species.

The only definite conclusions which are justified from the figures given are that tertian malaria was considerably more prevalent than subtertian at the beginning of the epidemic, but the latter increased in prevalence during the months of December and January; and that quartan malaria has played no part in the epidemic.

2. Clinical Description of Cases.

This section is compiled from reports which have been submitted by Dr. E. C. Spaar concerning the clinical aspects of patients admitted to the General Hospital, Colombo, Dr. S. Somasunderam and Dr. S. Ramanathan of patients admitted to hospitals in the Kandy District, and Dr. C. Candiah and Dr. C. G. Hoole of dispensary patients in the epidemic area.

Dr. P. B. Fernando and Dr. A. P. Sandrasagara have kindly supplied a typescript entitled " A Clinical Study of 647 Patients treated for Malaria during the Epidemic ". This is freely quoted in this section. It will be published in full at a later date in the Medical Section of the Ceylon Journal of Science.

Histories of Patients.—The salient question in the histories of patients who are admitted to hospital with malaria is whether or not they have had this infection previously. Dr. P. B. Fernando and his house physician, Dr. A. P. Sandrasagara, have analysed the histories for this information of 508 patients who were admitted to their wards between December and March; they found that 420 patients denied having had malaria prior to the present epidemic, the conditions of the spleens of their patients lend some support to the histories, because they found that the spleens of less than half their patients were palpable on admission. The following summarizes this infomation :—

Number of patients questioned	508
Previous attacks during the present epidemic	89
Attacks prior to the present epidemic	88
Patients denying attacks prior to the present epidemic ..	420
Number having palpable spleens on admission	207

The patients had been admitted to the General Hospital in Colombo and the majority of them come from various areas in or around Colombo, where the endemicity of malaria is very low in normal times (*Map No. 2*). Probably a history of malaria prior to the epidemic would have been given by a greater percentage of the patients in many of the other parts of the epidemic zone.

Species of Parasite causing the Infection.—This has already been discussed (page 46). It will be seen from the returns of the Pathologist of the General Hospital in Colombo that the number of persons who were admitted with subtertian malaria was more than double the number of those admitted with tertian malaria, but that patients admitted with the latter type predominated during March and April when the epidemic had declined. The hospitals were overcrowded during the height of the epidemic, and only patients with urgent symptoms could be admitted, and therefore a larger proportion of patients with subtertian than those with tertian, who came to the admitting and out-patient departments of the hospital, became in-patients.

Clinical Factors.—The clinical manifestations to be attributed directly to the malarial infection, or to complications, such as other infections and nutritional defects, have been of a bewildering variety during this epidemic, and in many cases correct diagnosis could not have been made without laboratory aids.

The clinical types will be divided into three main categories :—

(i.) The common type and its complications.
(ii.) Severe and unusual types.
(iii.) Malaria complicated by pregnancy.

(i.) *The Common Type.*—Six hundred and forty-seven cases of malaria have been studied by Dr. P. B. Fernando for types, and he describes 530 of them " as the common or ordinary type of malaria ". Nothing unusual has been reported in reference to the temperature charts.

A history of rigors was given by 418 out of 530 patients questioned, and this history was more frequent from patients with tertian than with subtertian infection, thus there was a history of rigors in 182 out of 237 cases of tertian infection, *i.e.*, 76.8 per cent., whereas similar figures for subtertian infection was 196 out of 298, *i.e.*, 65.8 per cent. The usual history in these cases was that the fever started with chills and rigors, but that these symptoms did not continue. There were forty-two patients who gave a history of having rigors daily or every other day, blood examinations showed that twenty-two were tertian infections, three were subtertian infections, seven were mixed, and the other ten were not classified. Therefore when rigors were frequent the infection was usually tertian. A similar observation was made at the Kandy hospital, and the report in discussing the chills, rigors and sweating as seen in the wards states " the fever was invariably of the simple benign type ".

Enlargement of the liver was not found in patients with acute malaria, but fifty of those who had given histories of previous attacks had some enlargement; this is roughly 6 per cent. for all malarial patients admitted to his wards.

Haematemesis is mentioned in nine cases; epistaxis in seven cases; haemoptosis in seven cases; and haematuria in three cases. The writers appear to attribute these haemorrhages entirely to the malarial infection, because they ceased after the administration of anti-malaria remedies.

Twenty-four cases of jaundice have been reported, sixteen from Colombo hospital among 530 cases, and six from the Kandy hospital.

Two cases of gangrene of the toes have been reported, one from Colombo and one from Kandy.

Among other signs and symptoms were vomiting which occurred in about 5 per cent. of patients and the observation from Kandy is that it was easily controllable. Several patients had hiccough. Urticarial rashes have been reported. Severe headache was reported to be uncommon.

With regard to complications, the healthy and those suffering from various diseases are equally liable to be infected with malaria during an epidemic, and it will often be impossible to assign certain symptoms to the malaria or to pre-existing conditions. For instance 70 per cent. to 90 per cent. of the poorer classes of the epidemic zone have been shown to be infested with hookworm, and consequently it is difficult to decide how much of the anaemia following an attack of malaria is due to the malaria parasite and how much to the hookworm.

The following were some of the complications which occurred among Dr. P. B. Fernando's 530 malarial patients :—

Puerperal sepsis ..	12	Diabetes	2
Pyelitis	8	Pyorrhoea	3
Pneumonia and pleurisy ..	7	Parotitis	6
Phthisis	10	Heart failure with oedema ..	6
Typhoid	4 (or more)	Epilepsy	2
Bronchitis ..	2	Nephritis	3
Asthma	3	Measles	1

(ii.) *Severe and Unusual Types: Cerebral Malaria.*—A large number of cerebral cases occurred during the epidemic. Dr. E. C. Spaar in an analysis of 350 cases placed 45 in the cerebral category which is 12.8 per cent. Dr. P. B. Fernando placed 54 of his 647 patients in this category which is 8.4 per cent.

——J. N. 56819 (9/35)

The majority of these patients on admission were either unconscious and comatose or were dazed and drowsy. A few patients (12 in Dr. Fernando's series) showed mental disorder such as queerness, hallucination, incoherent speech, loss of memory or maniacal violence.

One or two cases of each of the following conditions have been reported. Choreiform movements, dysarthria, pure motor aphasia, dysphagia, paralysis of the lower limbs, hemiplegia and ataxy of the cerebral type. The following interesting case is reported from the Kandy hospital:—

"A girl age 15 was admitted with loss of consciousness. The blood contained subtertian parasites. She had paresis of the left arm and leg, and the left pupil was dilated. There was no left plantar reflex. The patient died in a few days. A postmortem was done and showed congested meninges, and hæmorrhages along the external parieto occipital fissure; the cut surface of the brain in this area was red and congested from ruptured capillaries. Numerous subtertian parasites were seen in films made from the brain at the postmortem".

The results of the microscopical examinations of the blood are given by Dr. P. B. Fernando for his 54 cases as follows:—

Subtertian	41
Tertian	2
Mixed infection	6
Negative	5
	54

The mortality rate among patients with cerebral malaria was very high; 14 of Dr. E. C. Spaar's 45 patients died, *i.e.*, 31.1 per cent., and 17 of Dr. P. B. Fernando's 54 patients died, *i.e.*, 31.4 per cent. The latter in referring to those who died states, "All were infected with subertian malaria".

Algid Malaria.—Dr. P. B. Fernando placed 17 patients from his series in this category. He describes the condition as follows:—

"The patient is usually quite conscious, but lies silent, immobile, and staring into space. The temperature is frequently low or even normal, the skin cold, breathing shallow, pulse hardly perceptible but usually not fast, and the blood pressure remarkably low. In addition he may have vomiting or hiccough or both, two symptoms which make the prognosis very grave indeed. The picture in short is one of profound shock."

Cases of this type of malaria have occurred in all epidemic areas but the relative number of cases has not been determined.

Diarrhoeal and Dysenteric Types.—Many cases of these types have been reported, but whether the majority of them are due solely to the malarial infection or due to concomitant amoebic or bacillary infection has not been decided.

Dr. P. B. Fernando places eleven cases in those categories, and Dr. E. C. Spaar only 4; but there is a section of the Colombo hospital reserved for dysenteric patients and therefore it is probable that such patients would not be sent to Dr. Spaar's or Dr. Fernando's wards. The report of Drs. S. Somasunderam and S. Ramanathan for Kandy mentions 615 cases. They divide these cases under two headings—enteritis and dysentery—and separate the returns for adults from those for children and describe them as follows:—

"*Enteritis* (*adults*).—Very many of these patients were admitted in a moribund condition and died soon after. In the severer types the stools were watery, pale, frequent and very offensive; in the less severe types the stools became greenish and later yellowish and formed in about eight or ten days". They give the following table:—

		Admitted.	Died.	Death rate.
Malignant tertian in blood	Males ..	84 ..	35 ..	42%
	Females ..	90 ..	18 ..	20%
Benign tertian in blood	Males ..	15 ..	5 ..	33%
	Females ..	11 ..	7 ..	64%
	Total ..	200	65	32.5

"*Dysentery* (*adults*).—Dysentery in adults occurred in varying degree of severity (whenever parasites were found in the blood they were M.T. or M.T. and B.T.) in the severe types pure blood and lumps of gelatinous mucus were passed very frequently with severe colicky pain and tenesmus. Most of these were admitted in an emaciated and dehydrated condition, and many of them died. In the less severe types the blood disappeared from the stools in about three days but the mucus persisted and the tenderness usually passed off with the disappearance of blood. The stools became faeculent in about 4 or 5 days and formed in about two weeks time. At Kandy hospital in all cases the stools were examined microscopically but only in two were amoebae found. Bacillary dysentery was not suspected . . . ."

The following table gives the number and death rate of these patients:—

	Admitted.	Died.	Death rate.
Males	188 ..	52 ..	28%
Females	64 ..	27 ..	42%

The following table gives the number and death rate of the children admitted to Kandy hospital with malarial enteritis or dysentery:—

	Admitted.	Died.	Death rate.
Enteritis	59 ..	37 ..	63%
Dysentery	104 ..	45 ..	43%

Choleraic Type.—Five cases of this type have been reported, four were reported from dispensaries, and one from the Colombo hospital. The patient in the latter case had the typical signs and symptoms of cholera and was removed to the Infectious Diseases Hospital, films of the blood showed a heavy infection of subtertian malaria, but stools examined at the Bacteriological Institute were found to be negative for *V. cholerae*.

Respiratory Type.—All reports contain references to this type, but the evidences in the reports are not sufficient to prove that the malarial parasite may in some cases heavily infect the lungs and gives rise to various respiratory signs and symptoms, and to exclude the possibility of a concomitant bacterial infection. But there were patients who had haemoptysis and other signs and symptoms accompanied by a heavy infection with subtertian parasites, and who made a rapid recovery with anti-malarial treatment. Such cases give considerable support to the view that a heavy infection of malaria may give rise to various respiratory signs and symptoms.

Oedematous Type.—Medical Officers working in the epidemic areas have noted a large number of malarial patients who developed partial or generalized oedema during the later stages of the epidemic; it appears to have occurred far more commonly among children than adults (*Photograph 7*).

Several opinions have been expressed in the reports as to the etiology of this oedema; it has been attributed to anaemia following repeated attacks of malaria, to a concomitant hookworm infection, or to malnutrition; but possibly it is caused by a combination of these factors. Drs. P. B. Fernando and A. P. Sandrasagara have made a careful clinical and laboratory study of 19 cases and summarize their conclusions as follows :—

(1) There was no involvement of the kidneys. The examinations of the urine and blood urea have not shown any evidence of nephritis.

(2) There was no cardio-vascular changes. The blood pressure was normal. There were no signs of cardiac enlargement of congestive heart failure in any of the affected adults. In the case of two children, although there was some suggestion of congestive heart failure, the oedema and the clinical picture were not sufficiently explained by this.

(3) Six of the patients had hookworm infection.

(4) Although the majority of the cases had anaemia there was no correspondence between the degree of anaemia and the severity of the oedema. In some cases there was no anaemia.

(5) The condition was as common in B. T. infections as in M. T. infections. There were 6 M. T. cases, 6 B. T. cases, 4 mixed infection and no parasites were found in the blood of three patients.

(6) There was one feature common to all, it did not occur in patients during the primary infection, but in those who had repeated attacks of fever.

(7) Popular opinion blamed quinine as the cause. But in the great majority of our patients the only drug given was quinine, and the patients recovered. Those patients who were given atebrin responded equally well. The administration of plasmoquine to these patients has been quite harmless. Our personal opinion as to the nature of these cases is that they are of the same category as cases of ' famine oedema ' or ' war oedema '. The patients had been living for a long time on a diet of low value, and were finding it difficult to respond to the additional metabolic demands made by repeated attacks of fever. The comparatively good food given in hospital, the enforced rest in bed and the early control of the fever by the specific anti-malaria treatment all combined to remove the causes which produced the oedema, and affected a rapid and striking improvement.

The patients to whom the above refers were adults or older children, because young children are not admitted to the General Hospital.

The mortality rate among young children admitted to hospital with oedema following malaria appears to have been very high in parts of the epidemic area. The figures for children admitted to Kandy hospital are—

Admitted.	Died.	Death rate.
154	70	45%

(iii.) *Malaria complicated by pregnancy.*—Many pregnant women were admitted to hospital in the epidemic zone; most of them were in an anaemic and oedematous state. There was a high death rate among them, the women collapsing immediately or soon after abortion or premature delivery. The collapse was due in some cases to uncontrollable postpartum haemorrhage, but in other cases there was no haemorrhage and yet the women collapsed and died. The following were the death rates for two hospitals :—

	Admitted.	Died.	Death rate.
Kandy Hospital	95	23	24%
Gampola hospital	101	11	11%

All the Medical Officers who have discussed in their reports the influence which malaria has had on pregnancy have stated definitely that malaria was a potent cause of the interruption of pregnancies, and that the proper administration of quinine was far more likely to prevent this than to accelerate it. Unfortunately popular opinion has been contrary to this view and has hindered many women from seeking treatment at the dispensaries and hospitals.

Dr. G. A. W. Wickramasuriya has made a close study of pregnant women infected with malaria who were admitted to the De Soysa Lying-in Home in Colombo during this epidemic. He has prepared a long typescript of his observations, which will be published elsewhere in due course; and the following is an extract from this :—

Malaria can modify the natural course of pregnancy in the following ways :—

(i.) *Spontaneous interruption before term.*—This is a very common occurrence in women suffering from malaria. Whilst a mild attack of malaria may not adversely affect the course of the pregnancy, a severe attack or more particularly repeated attacks are very liable to bring on abortion, miscarriage or premature labour. This is a fact well known to practitioners in malarious districts. The epidemic has focussed attention to it still more strongly and I have witnessed many such cases in the wards of the De Soysa Lying-in Home during the past month. Very often the treatment adopted to cure the malaria is unjustly

> blamed for this unfortunate occurrence, and quinine has earned a notoriety—altogether undeserved in my opinion—in this connection. Many years of experience in malarious districts and the lessons learnt from the present epidemic have convinced me more than ever that malaria *per se* is a far more powerful oxytocic than any of the known drugs . . . .
>
> (ii.) *Intra-uterine death of the foetus.*—This is fairly frequent to judge by the frequency of births of macerated foetuses in cases of malaria, particularly malignant malaria, which cannot only bring miscarriage or premature labour but can also cause the death of the foetus *in utero*. But a far more important factor in causing intra-uterine death of the foetus is the massive infection of the placenta* with malaria parasites which is so often seen in cases of malaria of any degree of severity . . . .
>
> (iii.) *Toxaemia of pregnancy.*—As a result of the impairment in hepatic and renal activity which is so obvious in many of the severe cases, malaria must be considered to be a predisposing factor in the production of toxaemic pregnancy. The majority of the untreated cases and also those who have had several relapses showed albuminuria—more or less marked—with casts of various types including blood casts, and general anasarca and intense anaemia . . . . The frequent association of such toxaemic manifestations cannot be regarded as purely accidental and women suffering from malaria must be considered more prone to develop toxaemia, especially in the second half of pregnancy . . . .

Dr. Wickramasuriya has described three cases in which a new born child was found to be infected with malaria.

Blackwater Fever.—Ceylon has been mentioned in the literature as being one of the few countries in the world where malaria is common but blackwater fever does not occur. From time to time in past years a few cases have been reported but the records are not sufficient for definite conclusions.

Five cases of blackwater fever have been reported during this epidemic of which two were fatal. Drs. S. C. de S. Wijeratne and D. J. T. Leanage have investigated these and forwarded full notes on four cases which they consider are definite. The following are the notes on one of these cases:—

" Patient E. J. aged 20 years, a trader from Ahangama, was admitted to Civil Hospital, Galle on March 7, 1935, at 12.25 P.M. under the care of Dr. S. C. de S. Wijeratne, Visiting Physician. Dr. D. J. T. Leanage of the General Hospital saw the patient on the night of the 8th instant. A spectroscopic examination of urine was done for confirmation of diagnosis.

Previous History: The patient had been residing at Kurunegala during the last 10 years. He had first contracted malaria in 1928 and since then he had been suffering from malaria off and on. During the last three months he had several attacks for which he had been treated with quinine at Kurunegala and latterly at Ahangama. There was no history of syphilis or of having passed blood in the urine.

The present illness started with slight fever and malaise on the evening of 4th March, 1935. The following morning he had a severe rigor with a definite rise of temperature and vomiting of bile-stained fluid. He stated that he has never been so ill before. On the same day he passed dark coloured urine and became yellow. As his condition grew worse he was brought to hospital.

On examination there was marked pallor and the skin and sclerotics were jaundiced. Temperature 104, pulse 116 and regular, respiration 32. Tongue furred, heart and lungs showed nothing abnormal. The abdomen was somewhat distended, with a little tenderness over the right hypochondriac region. The liver was not palpable, the spleen enlarged two fingers below coastal margin. Persistent bilious vomiting was the most distressing symptom.

Urine.—Brownish black in colour, reaction acid and albumen present. The chemical test for blood was strongly positive. Microscopically there were a few granular casts and debris and no red cells. The spectroscope showed the presence of oxy-hæmoglobin.

Blood.—Red blood corpuscles 2,150,000; hæmoglobin 40 per cent.; colour index 0.9. Blood picture, few normoblasts. Differential count showed 72 per cent. polymorphs, 23 per cent. lymphocytes, and 5 per cent. hyaline. There were no malarial parasites and Vandenberg's indirect positive.

Treatment.—The bowels open with an enema. Mixture containing Sod: Bicard, Sod: Bromide, Acid Hydrocyanic dil. was given every four hours; glucose and saline half a pint four hourly by protocysis; mustard plaster applied to epigastrium. This had the desired effect in checking the vomiting which ceased altogether within 48 hours. The patient was also given glucose water with soda bicarb to be sipped frequently and king coconut water ad lib. On the 11th instant, milk and barley were given in addition.

With this treatment the patient's condition showed improvement within five days—temperature which was 104 on admission came down by lysis and reached normal on March 12, 1935. Urine was alkaline in reaction at all subsequent examinations. The change in colour was very striking—the brownish black urine of the 7th instant became normal on the 10th having gone through the intermediate shades of dark-brown and brownish-yellow on the 8th and 9th respectively. The quantity passed throughout was satisfactory.

Date.	Quantity. oz.	Colour.
7.3.35	38	Brownish black
8.3.35	66	Dark brown
9.3.35	49	Brownish yellow
10.3.35	71	Yellow
11.3.35	33	Pale amber
12.3.35 to 22.3.35	—	Normal

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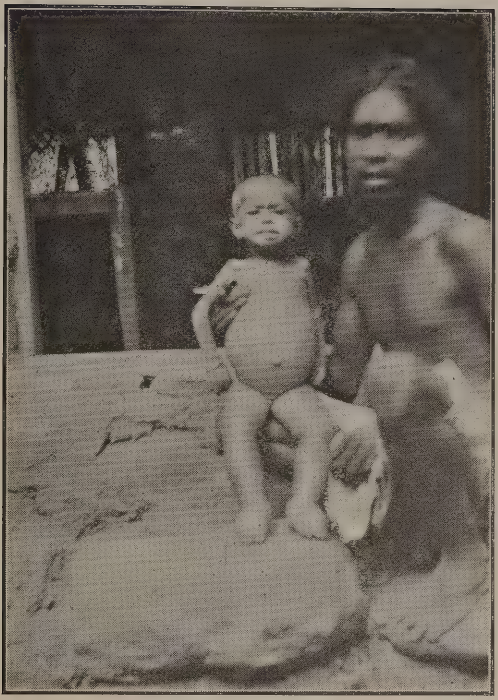
* A number of films have been made from placentas from women with malaria, and frequently the parasites are so numerous as to suggest actual concentration in the placenta.

Photograph 7.



OEDEMA IN A CHILD.

Photograph 8.

PATIENTS AT A TEMPORARY TREATMENT CENTRE (DECEMBER, 1934).

Photograph 9.

PATIENTS AT NARAMMALA DISPENSARY.

Samples of urine of the 7th and the 8th instant and blood films sent to the Pathologist, General Hospital, Colombo, confirmed the above finding as reported below.

Sample.	Appearance.	Reaction.	Albumen.	Deposit.	Spectroscope.
1	Black	Acid	.45%	Granular debris	Oxy haemoglobin
2	Darkbrown	„	.15%	do.	do.
3	Brown	„	.05%	Debris less	do.
4	Dark amber	„	faint	do.	do.

Blood Film.—Thin—no parasites seen. Thick—malarial parasite (? benign tertian). Stools were normal in colour, if anything a shade darker. Jaundice gradually disappeared in about 10 days leaving the pallor more marked. The later blood counts as shown below indicated definite improvement in the anaemia. Blood films were examined for malarial parasite every day with negative results. Wassermann reaction was negative.

Date.	Red blood corpuscles.	Haemoglobin.	Blood Pictures
11.3.35	2,150,000	40%	A few normoblasts
15.3.35	2,600,000	40%	Normoblasts and Polychromatophilia
18.3.35	3,000,000	50%	do.

On the afternoon of the sixth day the patient complained of a chilly feeling and the temperature rose to 103. Blood film examined immediately was negative for malarial parasite. Apart from the rise of temperature the urine remained normal and there was no vomiting or jaundice. He was put on atebrin tablets one, three times a day, for four days. The temperature returned to normal the following day and has remained so up to date.

The general condition of the patient has been very satisfactory. On the 17th atebrin was discontinued and he was put on an iron and arsenic mixture. Custard, milk puddings and jellies were included in the diet. Patient left hospital on the 22nd instant having recovered completely."

It may be concluded from this that blackwater fever occasionally occurs in Ceylon, but is such a rarity that only a few cases have appeared during this devastating epidemic.

3. **Treatment.**

Throughout the epidemic quinine has been the drug chiefly used by the Department. It is the practice of the Department always to keep in the Civil Medical Stores a reserve supply of quinine equal to the normal requirements for six or seven months. During the preceding four years the expenditure had been 14,725 lb. of quinine bisulphate in 1930, 13,409 lb. in 1931, 12,029 lb. in 1932, and 12,014 lb. in 1933. On November 1, 1934, 7,379 lb. of quinine bisulphate were in stock in the Medical Stores together with smaller amounts of other salts of quinine and of quinine tablets, and to maintain the next half year's reserve 7,000 lb. of the bisulphate had been ordered from England and were due to arrive early in 1935. On December 1 the stock in the Medical Stores had been reduced to 4,832 lb. and during the first twenty days of December quinine issues equal to four months' normal expenditure were made. Towards the end of the third week of December the issues rose to an average of 320 lb. a day and on December 19 the stock in the Civil Medical Stores had dwindled to 804 lb. One thousand pounds of quinine sulphate ordered urgently from Batavia were not due to arrive until December 26 and the consignment from England, although sent off by mail steamer, was not expected until January 6, so that a quinine shortage for a few days appeared imminent. The Government of India, however, in response to a cable sent on December 12, kindly agreed to allow the Ceylon Government to purchase 10,000 lb. of their reserve stock of quinine sulphate and the first consignment of 2,000 lb. arrived on December 20, and the remainder of the supply quickly followed. By January, therefore, there were ample supplies available for the next two months and a further order was placed in England for 10,000 lb. to arrive before the middle of February.

The monthly issues of quinine sulphate and bisulphate from the Medical Stores were as follows:—

	lb.
1934 October	967
November	2,547
December	8,134
1935 January	7,350
February	5,815
March	4,128
April	4,927
	33,868

In addition 1,529,650 tablets of grains iii., iv., and v., were supplied during the same period. The amounts of quinine issued represent about thirteen million days' treatment (when the dosage is averaged for adults and children).

The standard treatment for adults was one ounce three times a day of a mixture containing 7½ grains of quinine sulphate or bisulphate to the ounce. To outpatients a two days' supply (six ounces) has usually been given and the patient was advised to return for further supplies to enable him to continue treatment. Generally it was found wasteful to issue more than six ounces at a time, but patients and messengers who came from a distance were given larger supplies.

The average stay of malaria patients in Government hospitals was a little less than seven days, and routine hospital treatment has consisted of an ounce of the quinine mixture three times a day while the patient was in hospital and on discharge from hospital a further supply of quinine in mixture or tablet form was usually given to enable treatment to be continued at home.

The two great advantages of quinine are (*a*) the rapidity with which it reduces fever and alleviates symptoms and (*b*) its safety. The accident rate from quinine by mouth has been almost nil in spite of the fact that unqualified persons—dispensers, sanitary inspectors, vaccinators, medical students, and apothecary students—were in charge of many of the malaria treatment centres which were temporarily opened. The disadvantages of quinine were its bitter taste and the tinnitus, vertigo, slight deafness, and nausea from which many patients suffered while taking even the moderate doses given by the Department. Most patients, therefore, ceased to take the drug as soon as the symptoms of malaria subsided and the relapse rate has been high on account of insufficient length of treatment.

Intramuscular injections into the gluteal region of quinine bihydrochloride, usually in doses of 15 grains, have been given by medical officers both in hospitals and, to a limited extent, in the field. About a third of the patients so treated have subsequently complained of pain and soreness at the site of injection. Thus, in a series of 424 hospital in-patients each of whom received two intramuscular injections, these symptoms occurred in 134 of the patients or 31.6 per cent. Abscess formation has been uncommon and did not occur among the 424 patients mentioned above. Tetanus as a sequela has been reported only once during the past five years and not at all during the epidemic.

Most medical officers in Ceylon prefer the intramuscular route to the intravenous when the patient cannot take quinine by mouth. Intravenous injections have been given only in grave cases of malaria and in such cases the blood pressure has often been abnormally low. Intravenous administration under these conditions has been found liable to cause shock and collapse, particularly when the systolic pressure has been below 90 mm. In cases with low blood pressure it has, therefore, been the practice to treat the patient with injections of adrenaline, pituitrin, salines, &c., and to give quinine intramuscularly.

The rectal administration of quinine has been attempted. While enemata containing 15 to 20 grains caused pain and tenesmus and were almost invariably rejected within a few minutes, Dr. S. Somasunderam found that 20 grains of the bihydrochloride given in half a pint of normal saline by slow proctoclyis were usually retained without discomfort to the patient and were absorbed.

In the treatment of malaria during pregnancy Dr. G. A. W. Wickramasuriya considered that " far from being an oxytocic, quinine administered in effective therapeutic doses, by rapidly controlling the malarial infection and the high temperature, prevents premature interruptions of pregnancy and intrauterine foetal death ", and his views have been generally confirmed by other medical officers.

From November to the end of March 83,000 tablets of plasmoquine and 45,100 tablets of quino-plasmoquine were issued. On account of the known toxic effects of plasmoquine, it was used only in hospitals and was generally given in conjunction with quinine. No medical officer has expressed any definite opinion on its therapeutic properties. There was no opportunity of determining whether it had any effect in reducing the relapse rate in benign tertian malaria and the conditions under which its gametocidal properties in subtertian malaria can be put to practical use, are very restricted.

Atebrin was used fairly extensively in the Government hospitals, but was considered unsuitable for dispensary use or mass treatment (*Press communique, December 21*), 179,000 tablets were issued. The use of atebrin aroused considerable interest and from the middle of April to the end of May careful comparative tests were made with the new soluble preparation—atebrin mussonate (*Appendix 4*).

Dr. P. B. Fernando in describing the treatment of serious cases of malaria writes as follows:—

> " Although the average case of malaria may be treated on standard lines, with equally good results whatever the anti-malarial drug used, the serious cases—the algid, cerebral, and heavy infections—offer the most perplexing problems.
>
> We have had 71 algid and cerebral cases in our series besides a number of very severe infections, 70 per cent. of the former recovered and almost all of the latter. The following observations, based on our failures as well as on our successes, may be of help:—
>
> (1) The most important thing is undoubtedly correct diagnosis. It is not enough to diagnose the nature of the infection. The degree and severity of the infection must be discovered. A very useful method is actually to enumerate the number of parasites in each field of the microscope. A report such as ' M. T. rings (70-80 in each field) ' means undoubtedly a case for the utmost promptitude and vigour in treatment.
>
> (2) Sometimes it may not be possible to get the blood examined at once. The blood pressure reading is of great value in estimating the gravity of the case. It takes only a few minutes. In our opinion every doctor who is in charge of malarial patients should equip himself with a B. P. instrument and use it as frequently as he would use his stethoscope or thermometer.
>
> (3) Having diagnosed the case as serious the problem is how best to treat the patient. The drug we used in almost all our serious cases was quinine. Now in such cases oral administration is not sufficient. Many of the patients may be unconscious and unable to swallow. It is here that the estimation of the blood pressure becomes of the utmost value. Our advice is never to give quinine intravenously if the blood pressure readings are below S90. It will cause a further fall of blood pressure from which the patient may never recover. An intramuscular injection of 20 grains of quinine bihydrochloride should be given at once. At the same time give adrenalin mx. intravenously and saline and glucose should be given either by the intravenous, the subcutaneous or the rectal route. Caffeine and sodium benzoate, pituitrin, and coramine intravenously or intramuscularly are other useful injections which may all be repeated till the patient has sufficiently recovered from the shock. If his malarial condition has not improved while the circulatory failure has recovered after an hour or so as shown by a rise in blood pressure, an intravenous quinine injection may now be given. The preparation we found best was an 8 c.c. ampoule containing 6 grains of quinine bihydrochloride. The ampoule should be warmed to the body temperature and the contents injected very slowly, taking about one minute for each c.c. of the solution. The injections for combating the fall of blood pressure, &c., should be continued as before. The majority of patients recover by this method. The injections of quinine may have to be repeated for several days before the patient has fully recovered.

Some patients improve up to a point; the deep coma is replaced by partial consciousness, but the patient takes no food or fluids by mouth. In such cases we always passed a nasal tube, and gave the quinine together with milk, glucose, &c., by this route.

We have used atebrin by injection in a few very severe cases and have found no evidence to encourage its extended use in severe cases of malaria. The fall of blood pressure following the intravenous administration of quinine was a serious disadvantage. When atebrin mussonate was first introduced, expectation were raised that perhaps here was the ideal drug which while rapidly destroying the parasites would not produce any circulatory failure. The following cases showed its limitations:—

The first case—male 30—was admitted on February 1 in a semi-conscious state; he had rigidity of the right arm and of both legs, also rigidity of the neck muscles. The pupils were dilated but reacted to light. The abdominal reflexes were lost on both sides and there was a Babinski on the left foot. His blood pressure was 98/58.

Blood, M.T. rings + + + (about 30 in each field).

A lumbar puncture withdrew clear fluid under moderate tension. Atebrin mussonate 0.125 gramme was given intravenously and 0.25 by intramuscular injection.

Next morning patient was still semi-conscious; swallowed water—blood pressure 100/75.

Atebrin 1 tablet was given through a nasal tube and two atebrin hydrochloride tablets given by intramusculor injecton. A blood film was taken and it showed about the same number of parasites in each field (30).

The evening of February 2: Patient became suddenly worse and died.

Postmortem showed the brain congested and with parasites.

In another case, one of cerebral malaria., where atebrin mussonate .125 was given intravenously twice, 3 tablets of atebrin hydrochloride intramuscularly and 10 tablets, some by the mouth and some through a nasal tube, the patient recovered slightly from his comatose state, but never more than half regained consciousness. He died at the end of the atebrin course.

A third patient who was a very low algid case with M. T. + + + recovered from the first attack., but three days after the end of the course, developed a relapse with parasites and died.

The fourth case which was an algid malaria recovered after 3 bulbs of atebrin mussonate intramuscularly and 1 of atebrin hydrochloride intramuscularly.

Thus in three out of four really bad cases of malaria it was not fair to the patient to withhold quinine ".

4. Pathology of Malaria.

Material from thirty-three autopsies was investigated. The period under investigation was from October 1, 1934 to February 28, 1935. The number of postmortem examinations done in each of the five months is given below.

October	November	December	January	February
1	1	9	12	10

Postmortem Findings.—Pathological changes were most evident to the naked eye in the brain, spleen and liver. No obvious pigmentation was noticed in the skin probably due to the natural brownish pigmentation of the skins.

Meninges: In twelve cases there was hyperaemia of the meninges. In three meninges were paler than usual. In the rest of the cases no changes were apparent.

Brain: In eight cases the brains had a characteristic smoky grey colour. In twelve there was hyperaemia of the cortical surface. Three brains were paler than normal. In one there was a definite haemorrhage in the parietal region. In three there were punctiform haemorrhages. In the rest no naked eye changes were seen. Brain " crushes " were positive for subtertian malaria in twenty-one cases. Positive brain " crushes " showed capillaries plugged for long distances with parasites within red cells. In a few cases the parasites were alive and active.

Histology: Histological pictures varied greatly. In typical cases of cerebral malaria the vessels were found to contain large numbers of parasites mostly in red cells. They were in all stages of asexual development. There was a marked tendency on the part of parasitized red cells to adhere to the inner surface of the blood vessel. Most of the red cells in the central part of the vessels were found free of parasites as has been confirmed by the fact that in cases of haemorrhage most of the red cells were free of parasites. Haemorrhages were not found in all cases and when found they were irregular in distribution and extent.

In one case there was proliferation of vascular endothelium with accumulation of neuroglia cells around it.

Some cases showed the presence of large numbers of macrophages containing parasites and pigment, in the vessels. In noncerebral cases neither parasites nor pigment were found in the brain.

Lungs: The following changes were noticed in the lungs:—

	Cases.		Cases.
Pulmonary oedema in	8	Subpleural ecchymosis in	2
Hypostatic congestion in	4	Emphysema in	2
Pleurisy with effusion in	3	Lobar pneumonia in	1
Pleurisy with adhesion in	3	No changes in	8
Lobular pneumonia in	3		

Films made from the blood of some of the lungs showed the presence of parasites in all stages of development.

Heart: The commonest change in this series was the pale flabby heart; it was found in five cases. There was sub-pericardial ecchymosis in one case, pericardial effusion in another. There was atherosclerosis of the coronary vessels in two specimens, marked dilation of right ventricle in two cases. In one case the heart had undergone atrophy, postmortem blood smears from some cases showed the presence of malarial parasites.

Liver: In this series twenty-four showed macroscopic changes whilst the other nine appeared unchanged. The livers that had changes were moderately enlarged and pigmented, the colour varying from grey to dark brown. Some livers were yellow due to fatty changes.

Pigmented slaty grey, chocolate brown, and dark brown ..	9
Yellowish and fatty	8
Enlarged without any colour change	4
Hyperaemia	2
Decomposed	1

Histology: Liver showed the presence of pigment in the Kuppfer cells in varying amounts and parasitized red cells in blood vessels.

Spleen: In thirty-one cases spleens were moderately enlarged. The colour varied from grey to tarry black depending on the quantity of pigment. Anæmic infarcts were observed in four cases. Perisplenitis in one.

All the spleens were soft and mushy. The cut-surface too showed the same range of colour as the exterior. Malpighian corpuscles were less obvious than usual. Parasites in many cases.., and pigment in all, were found in smears.

Histology: All the spleens showed a varying amount of malarial pigment and parasites. Four cases had infarcts. The infarcts were probably due to intravascular blockage of vessels.

Kidneys: Kidneys showed little beyond hyperaemia. Only in one case kidneys showed evidence of pigmentation. In another case pin-point haemorrhages were seen in both kidneys.

Histology: Kidneys too showed the presence of varying amounts of pigment. No characteristic glomerular or tubular changes were noted.

Stomach and Intestine: Changes were evident only in a few instances. In two cases there was hyperaemia of stomach. In one instance there was oedema of mucosa of the stomach, in another there was punctiform haemorrhages in the rectum. In one case where a malarial patient died of peritonitis there was a single perforated ulcer in the lower part of the ileum. In one case intestines had a definite slaty colour.

Uterus and placenta: In five cases of postpartum deaths, smears of urine surface and material surface of placenta showed presence of parasites.

Adrenals: Adrenals were examined carefully in two cases of marked low blood pressure. No characteristic cellular lesions were present.

SECTION V.

MEDICAL ORGANIZATION.

1. Normal Organization of the Department of Medical and Sanitary Services.

The Civil Medical Department was formed in 1858 and has always been chiefly concerned with the provision of medical relief to the population of the Island by means of hospitals and dispensaries. There are 97 general hospitals with 7,868 beds scattered throughout the nine provinces, as well as a number of special hospitals, *e.g.*, for eye diseases, tuberculosis, leprosy, and mental diseases, which accomodate 3,501 patients and are mostly in or around Colombo. Each general hospital has its out-patient department and in addition there are 221 central dispensaries, 156 branch dispensaries and 247 visiting stations. A central dispensary is in charge of a resident medical officer or apothecary and is usually open every day for the treatment of patients; a branch dispensary is visited by the medical officer or apothecary of a hospital or central dispensary two or three times a week on fixed days and at a stated hour and consists of a small building generally with two rooms and a verandah, in which a stock of drugs is kept and a caretaker stationed; a visiting station is a place visited once or twice a week by the neighbouring medical officer or apothecary, who brings a supply of drugs with him on each occasion and the room where patients are seen is frequently in some Village Committee building or occasionally in a school.

The following figures give the total number of in-patients and out-patients treated annually over a period of ten years showing in each case the percentage treated for malaria.

	In-patients.		Out-patients.	
Year.	Total Number.	Percentage treated for Malaria.	Total Number.	Percentage treated for Malaria.
1924	176,787	15.2	2,497,122	37.0
1925	188,354	12.0	2,360,468	33.3
1926	205,529	14.2	2,864,733	36.9
1927	200,770	12.5	2,759,403	31.4
1928	224,850	19.7	3,482,691	44.2
1929	210,547	17.8	3,626.606	44.6
1930	208,464	18.0	3,810,010	45.2
1931	191,864	14.4	3,714,348	38.2
1932	207,922	15.7	3,965,209	38.0
1933	207,028	11.1	3,765,231	31.8

It should be noted that the figure for outpatients is the actual number of first visits and not that of total attendances. Thus, in 1933 there were 3,765,231 first visits and 1,969,329 subsequent visits making a total of 5,734,560 attendances. (Each first visit however does not represent a separate person but a separate case of disease.)

In each province there is a senior medical officer of the Department known as the Provincial Surgeon whose chief duties have been the inspection and control of the hospitals and dispensaries of his province. In any serious emergency he is in a position and has authority to mobilize quickly all the medical resources of his province and to act at once.

When there are minor outbreaks or undue prevalence of malaria and the facilities for treatment given by the local dispensary are insufficient, the usual practice has been for the Provincial Surgeon to open additional visiting stations temporarily in the affected villages or to detail according to the gravity of the situation a medical officer, apothecary, or vaccinator to itinerate the area and distribute quinine.

The public health or sanitary branch of the Department is of more recent growth and is smaller than the medical branch. Ordinary public health duties are carried out by whole-time Medical Officers of Health and there are 25 areas each with a Medical Officer of Health and staff of trained Sanitary Inspectors. The Anti-Malaria Campaign, Sanitary Engineering Division, and Medical Entomlogist's Division as well as other special activities such as the Ankylostomiasis Campaign also form parts of the Sanitary Branch of the Department.

The technical personnel of these special divisions was as follows before the start of the epidemic:—

Anti-Malaria Campaigns.

1 Superintendent
1 Medical Officer
13 Sanitary Inspectors

Sanitary Engineer's Division.

1 Sanitary Engineer
3 Assistant Sanitary Engineers
1 Head Overseer
3 Draughtsmen

Medical Entomologist's Division.

1 Medical Entomologist
12 Entomological Assistants
12 Field attendants
3 Laboratory Assistants

Ankylostomiasis Campaign.

1 Superintendent
32 Dispensers
8 Microscopists

The Ankylostomiasis Campaign is mentioned because of the use made of its staff during the epidemics.

Malaria control measures are planned and arranged by a Departmental Malaria Committee consisting of the Assistant Director of Sanitary Services as Chairman, the Medical Entomologist, the Superintendent of the Anti-Malaria Campaign, and the Sanitary Engineer as members and the Senior Medical Officer of Health as Secretary. The actual carrying out of the measures is done by the local Medical Officer of Health with local labour, but with the help of Sanitary Inspectors specially trained for malaria work and of one or more Entomological Assistants. Organized efforts to deal with malaria were first begun in 1911 at Kurunegala and the early work has been described by S. T. Gunasekara (1913). Since the general malaria survey of 1921-22, the work of the Anti-Malaria Campaign has been principally directed to the control of malaria in certain demonstration areas, viz., Anuradhapura, Trincomalee, Puttalam, Chilaw, Kurunegala, and Badulla, where anti-larval measures, drug prophylaxis and occasionally major drainage schemes have been undertaken. Malaria control has also been undertaken for special reasons at other places, *e.g.*, at Mahara Jail, at certain railway stations, and in connection with the Minneriya Colonization Scheme and Kataragama pilgrimage.

Extra Personnel.—It is necessary to mention the sources from which additional staff can be drawn to treat malaria. The personnel available in Ceylon with sufficient medical training or experience to undertake treatment in connection with the epidemic consisted of doctors, apothecaries, dispensers, and vaccinators.

The Ceylon Medical Register contains 824 names. Eighty-nine are those of unqualified persons who were registered because they were practising medicine when the register was started in 1907. Except for these unqualified men, only persons eligible for registration under the English Medical Act of 1887 may have their names placed in the Ceylon register. Of the qualified medical practitioners whose names appear in the register a number are no longer resident in the Island and others have retired from practice. There were, therefore, less than 700 qualified persons actively engaged in the practice of medicine when the epidemic started. Of these, 324 were holding permanent appointments and 22 temporary appointments in the Department of Medical and Sanitary Services, and the Department had a list of the names of another 52 who were willing to undertake acting duty under Government.

Apothecaries are persons who have received a two years' course of training in pharmacy and elementary medicine and surgery at the Ceylon Medical College. There were at the beginning of December, 1934, 357 holding appointments in the Department and 84 willing to undertake acting duties. They may all practise pharmacy, but only while employed by Government or on scheduled estates may they undertake treatment.

Dispensers are of two kinds. There are the 32 Ankylostomiasis Campaign dispensers employed by the Department. They are accustomed to working in Government hospitals and dispensaries as well as in villages, schools, and on estates. They have all had several years of useful practical experience and know how to dispense drugs, deal with patients and keep records, but their knowledge of medicine is limited. Then there are the approved estate dispensers numbering 815. They are men who have some practical knowledge of dispensing and who after passing an elementary test in the duties of an estate dispenser are approved by the Department and permitted to be employed by estates to treat minor ailments among estate labourers.

137 Vaccinators are employed by the Department. They receive no training in medicine, but are accustomed to act as quinine distributors in the rural areas in addition to their normal duties, and there are pupil vaccinators who are always ready to accept temporary employment. The vaccinators are familiar with the remotest parts of the provinces in which they work and they make shift for themselves and manage better than temporary officers.

2. **Emergency Organization.**

(*a*) *Official.*—In the early stages of the epidemic, before its future severity was realized, Provincial Surgeons followed the customary procedure and sent round itinerating apothecaries and quinine distributors and increased the number of visits to branch dispensaries and visiting stations. But it soon became obvious that this system was inadequate for an epidemic of the proportions which were then developing. By the end of November the permanent staff of the Department had been largely supplemented with temporary officers but these officers did not know the districts, they had transport difficulties and breakdowns and they were diverted from their set itineraries to see urgent cases elsewhere, so that villagers often waited many hours for treatment which did not arrive. A Ceylon village covers a large area as the houses are widely scattered and the distance from one end of the village to the other may be one or two miles. The number of houses that an officer could visit in a day was therefore small—40 appeared to be the maximum—and it was very evident that sufficient staff could not be raised to treat the sick in their own homes. Better service was given to the villager when the officer remained in one place where he could be found. Provincial Surgeons were accordingly instructed to open a treatment centre in every group of badly affected villages, if no hospital or central or branch dispensary was there already. In thickly populated areas these centres were opened at distances of three miles or less so that no patient or messenger requiring quinine had far to travel.

Many branch dispensaries and visiting stations which normally were visited once or twice a week were staffed with resident officers, as were the larger treatment centres and were kept open every day. In more sparsely populated areas where the officer in charge of the treatment centre had insufficient work to keep him occupied all day, he was given two or three subsidiary centres, usually within three miles of his main station, each of which he visited at a fixed hour on two or three afternoons a week. There was no need, therefore, for any villager to go more than a mile or two for medicine for himself or for sick members of his family.

It was at the same time necessary to increase very greatly the out-patient staff of doctors, apothecaries and orderlies at the hospitals and permanent dispensaries. During the height of the epidemic these institutions were thronged with patients (*Photographs 8 and 9*) from early morning until late at night and the officers were frequently kept at work from 7 A.M. to 10 P.M. During this period at any hour of the day the neighbourhood of a hospital or central dispensary was conspicuous by the processions of bullock carts—often with a whole family in a cart—conveying unconscious or feeble patients for treatment and by the large numbers of people coming away carrying bottles of the eosin tinted quinine mixture. At the hospital or dispensary itself comatose patients, children in convulsions, patients vomiting and collapsed were usually to be found and these patients required considerable and prolonged attention. It was on account of such patients that treatment centres, which originally were supplied only with quinine and salts, were given a large range of drugs and equipment if the officer in charge was competent to use them, *i.e.*, if he was a doctor or apothecary.

By the third week of December when the number of outdoor attendances was at its maximum, 261 treatment centres and 429 sub-centres had been opened in the epidemic area where 38 permanent hospitals and 80 central dispensaries were already in existence (*Map No. 20*).

59 medical practitioners and 284 apothecaries, dispensers and vaccinators were temporarily engaged and employed in the epidemic area. Certain of the normal activities of the Department were discontinued so that the personnel might be employed on malaria duty. Thus three Inspecting Medical Officers of Estates, the Superintendent, Ankylostomiasis Campaign, two School Medical Officers, and ten Medical Officers of Health assisted the Provincial Surgeons to arrange and supervise the malaria treatment measures. Medical Officers of the Department who could be spared from hospitals outside the epidemic area were also made use of and later a number of retired Medical Officers rejoined the Department temporarily. The dispensers and microscopists of the Ankylostomiasis Campaign were very useful, the former for staffing treatment centres and the latter for examining blood films at hospitals. During the Christmas vacation of the Ceylon Medical College which coincided with the peak of the epidemic, 17 medical students and 33 apothecary students volunteered for malaria duty and were posted to dispensaries and treatment centres.

The Provincial Surgeons in the affected areas had been instructed (*Appendix 5*) to draw on all the medical resources in their provinces, whether of the medical or sanitary side of the Department. The Medical Officers of Health were assisting in the opening and supervision of treatment centres, in keeping them supplied with drugs and in ensuring that the temporary officers carried out the duties required of them and were replaced quickly whenever they fell sick with malaria and could not work.

The Sanitary Inspectors at first were employed to distribute quinine and to staff some of the temporary centres, but it was soon found that there were more important functions for them to perform. Accurate information about conditions in the villages was essential, since misleading reports were pouring in. Instructions (*Appendix 6*) were, therefore, issued that the Sanitary Inspectors should be employed to keep the Department informed of the state of the villages in their ranges. An Inspector was required to visit and report on each village once every week or ten days. At the visit he gathered information about the amount of malaria in the village and the progress of the epidemic, he entered houses and noted the number of persons in the family suffering from malaria, the number who had recovered and were able to work, whether there was difficulty in getting quinine for patients, the distance to the nearest treatment centre, whether food was available and to what extent there was destitution and starvation. He took with him a small supply of quinine for emergency treatment and one of his duties was to see that the village headman made arrangements to send for medicine for any household where all were incapacitated. At the end of the day the Inspector sent a short report to his Medical Officer of Health and a copy to the Provincial Surgeon on each village visited, giving the population and number of malaria patients in the families seen by him and mentioning any lack of facilities for treatment or relief. With this information available Provincial Surgeons were able to decide promptly where additional treatment centres were needed or what re-arrangement of existing centres was necessary.

The duties of the Sanitary Inspector were added to and became very heavy, so that during the second week in January suitable men were engaged to supplement the work of these Inspectors. At a later date, since the schools had been closed in the worst parts of the eipdemic area, the teachers were called on to perform similar work in the neighbourhood of their schools.

Shortly after the epidemic had passed its peak as regards dispensary attendances, the number of patients with very acute manifestations of malaria became fewer and a different type of case began to preponderate. Many households either could not obtain food or could not prepare it while all their members were ill, and the villager holds the view that a person recovering from fever should take only coriander water and rice conjee until convalescence is well established. A large proportion of patients, especially children, were suffering, therefore, not only from the after effects of malaria but from lack of proper food also, and cases of severe debility, anaemia and oedema became numerous. The oedema was regarded as a manifestation of deficient nutrition and occurred chiefly in children, but in certain areas 7 or 8 per cent. of all out-patients showed signs of it. Early in January, therefore, the Department supplied its hospitals and dispensaries in the badly affected areas with Horlick's Malted Milk and Lactogen for issue to under-nourished children suffering from post-malarial debility (*Appendix 7*). These milk foods were issued only when they were required on medical grounds for the treatment of the patient and were not considered to be a relief measure. 17,040 lb. of Malted Milk, 18,656 lb. of Lactogen and 2,544 lb. of Glaxo were supplied. A little later a simple tonic mixture (*Appendix 8*) which could be prepared in bulk and could be safely entrusted to unqualified officers in charge of treatment centres, was supplied in large quantities. The temporary hospitals and convalescent homes to be described later were of special value for the treatment of these debilitated patients.

Extra Hospital Accommodation.—Until the peak of the epidemic was reached the number of hospital inpatients did not become excessive but after the third week of December the need for more accommodation increased rapidly and in most parts of the epidemic area continued to do so until towards the end of February. On December 22, 1934, instructions were given to Provincial Surgeons for temporary wards to be built at a number of hospitals in the worst areas, and by this means increased ward accommodation was provided for about 1,000 patients. Table 26 shows that the 38 Government general hospitals in the epidemic area, with permanent beds for 4,000 plus the new temporary wards, were accommodating 6,500 patients on March 6, a date just after the period of maximum congestion. The rate of decline was slow and there were still 5,358 in-patients on April 10. These numbers include patients suffering from all diseases, but except at the General Hospital, Colombo, between 70 and 90 per cent. of the patients were admitted for malaria. The average stay in hospital of patients suffering from malaria was just under seven days.

TABLE 26.

Hospitals in the epidemic area, their permanent bed strength, temporary ward accommodation, number of in-patients on March 6, and on April 10.

Hospital.	Permanent Bed strength.	Temporary Ward accommodation.	No. of In-patients. Mar. 6.	April 10.
Colombo District.				
1. Avissawella	140	90	347	260
2. General Hospital, Colombo	924	—	1,102	1,141
3. Gampaha	44	—	77	67
4. Moratuwa	54	—	67	59
5. Negombo	80	—	159	125
6. Watupitiwela	52	—	47	37
Kalutara District.				
7. Ingiriya	98	23	218	175
8. Kalutara	46	—	72	54
9. Neboda	90	—	53	35
10. Panadure	44	24	95	76
11. Pimbura	90	—	122	119
Kandy District.				
12. Dolosbage	47	—	70	50
13. Gampola	100	32	165	106
14. Kandy	276	130	414	508
15. Madulkele	64	—	60	27
16. Nawalapitiya	111	50	273	279
17. Teldeniya	41	40	137	93
18. Watawala	41	—	73	47
Matale District.				
19. Matale	173	—	182	128
Kurunegala District.				
20. Dambadeniya	48	40	126	92
21. Dandegamuwa	64	48	147	93
22. Kurunegala	184	164	541	334
23. Ridigama	78	—	127	77
Chilaw District.				
24. Chilaw	60	—	136	117
25. Marawila	59	—	54	52
Ratnapura District.				
26. Balangoda	126	—	137	136
27. Embilipitiya	8	—	12	14
28. Kahawatta	134	—	143	107
29. Kaltota	8	—	2	8
30. Kolonna	50	—	46	32
31. Rakwana	74	—	76	68
32. Ratnapura	112	—	172	165
Kegalla District.				
33. Aranayake	77	25	99	97
34. Eheliyagoda	38	—	50	42
35. Karawanella	120	50	193	149
36. Kegalla	102	250	307	239
37. Kitulgala	94	—	122	98
38. Undugoda	56	—	77	52
Total	4,007	966	6,500	5,358

Some extra accommodation for malaria patients was arranged in other ways. Thus, at the General Hospital, Colombo, the two tuberculosis wards containing 80 beds were made available by transferring their patients to the Ragama Tuberculosis Hospital, at Ingiriya the Infectious Diseases Hospital, with accommodation for 28 patients, was used for cases of malaria and similar arrangements were made at Kandy and several other hospitals.

As a further measure to relieve congestion in the Government hospitals and to bring facilities for treatment closer to the affected villages, the Department opened a number of temporary hospitals (*Table 27*). The first of these was started at Polgahawela in the Labour Depôt buildings on January 1, 1935, and most of the others were opened in February. Government vernacular schools which had been closed because of the falling off in attendance consequent on the epidemic were whenever possible selected for hospital purposes. Most of these schools are built to a type plan and are spacious, well ventilated and have concrete floors. There are usually two separate buildings, one for boys and the other for girls, which made good temporary wards for males and females, and the school teachers' quarters provided living accommodation for the apothecary. The school latrines were unsuited to hospital requirements and bucket latrines built to a standard pattern were constructed by the Medical Officer of Health of the district for each temporary hospital (*Appendix 9*).

The staff of a temporary hospital consisted of a visiting medical officer, a resident apothecary or dispenser, a trained nurse (when quarters for her could be found), male and female ward attendants, dhoby, and latrine labourer. Dieting was done by contract. Table 28 gives the scale of equipment. In most cases the equipment, staff and latrines necessary to convert these schools into hospitals were arranged within a week. Only malaria patients were admitted and it was laid down that really serious cases and cases complicated with pneumonia or dysentery should be removed to a permanent hospital. The type of case treated in the temporary hospitals, therefore, was mild and the deaths that occurred were few and were mostly confined to patients brought to the hospital in a dying condition. The hospitals were of particular value for the treatment of children and women and at some of the smaller temporary hospitals a ward for adult males was not provided. Twenty-two of these hospitals with accommodation for about 1,300 patients were opened:—

TABLE 27.

Government Temporary Hospitals.

Place.	Date of Opening.	Accommodation. No. of Beds.
Western Province.		
Mirigama	15.2.35	65
Kirindiwela	11.2.35	75
Biyagama	11.2.35	60
Hanwella	12.2.35	75
North-Western Province.		
Wariyapola	13.2.35	100
Weuda	14.2.35	36
Hettipola	10.2.35	60
Narammala	4.2.35	75
Polgahawela	1.1.35	65
Wellawa	21.2.35	50
Tirigama	22.2.35	50
Buluwela	25.2.35	44
Ambanpola	1.3.35	50
Handalankawa	5.3.35	50
Nedalagama	18.3.35	50
Alawwa	1.3.35	65
Sabaragamuwa Province.		
Deraniyagala	19.2.35	74
Rambukkana	11.2.35	56
Mawanella	15.2.35	78
Dedigama	14.2.35	52
Mattamagoda	13.2.35	66
Central Province.		
Pallebage	1.4.35	50

TABLE 28.

Equipment for a Temporary Hospital of Fifty Beds.

150 mats
100 coir pillows
200 cases for coir pillows
250 check cloths
100 bed covers
50 blankets, blue
80 shirts for men
80 jackets for women
100 shirts for children
50 plates, enamelled
50 mugs, drinking, aluminium
8 chamber pots, enamelled
6 hurricane lanterns
8 buckets, latrine
4 dozen towels
2 basins, enamelled
2 jugs, enamelled
2 soap dishes, enamelled
4 buckets, ordinary
2 baskets for soiled linen
12 bars, Sunlight soap
3 bars, carbolic soap
4 brooms, coir
2 brooms, ekel
2 brooms, bass
15 gallons Jeye's fluid
50 yards Mackintosh
4 dozen dusters
50 mattresses
4 tubs, bath
50 beds
2 almirahs, 4 ft. by 6 ft.
3 meat safes
4 wash hand stands
1 table for dispensary

(*b*) *Voluntary Organization.*—The enormous amount of voluntary service rendered during the epidemic cannot be described in detail in this report. It was spontaneous and unofficial and records of much of it do not exist. The assistance given by voluntary workers took many forms, but was chiefly concerned with relief and treatment, and the medical activities may be roughly classified as follows:—

(*a*) Establishment of kitchens for hospital and dispensary outpatients.
(*b*) Treatment of villagers by Estate Superintendents and their dispensers.
(*c*) Establishment of temporary hospitals and convalescent homes.
(*d*) Miscellaneous activities such as the free transport of the sick, supply of hospital clothing, and child welfare.

Kitchens for Out-patients.—From the middle of December until towards the end of January, that is when dispensary attendances were most numerous, voluntary workers established simple kitchens, usually under a cadjan shelter (*Photograph 10*) in the grounds of or close to busy dispensaries and hospital out-patient departments. At these kitchens patients coming from a distance could rest and obtain refreshment. The comforts generally given were rice conjee, tea,

Photograph 10.

TEMPORARY KITCHEN FOR OUT-PATIENTS.

Photograph 11.

TRANSPORT OF PATIENTS BY BULLOCK CART.

Photograph 12.

IMPROVISED STRETCHER (KANDY DISTRICT, DECEMBER, 1934).

malted milk, coriander water, and barley water and at some of the kitchens patients were given a packet of rice, sago or sugar or a small tin of condensed milk to take home. Occasionally the kitchen staff also undertook the issue of the Department's malted milk or Lactogen to children, on prescriptions from the doctor or apothecary treating the patients.

At Rambukkana and Kadugannawa, the Salvation Army took charge and at other places local residents conducted the kitchens. The food and drinks were either gifts of the people of the locality or were paid for by the Government Agent from the Malaria Relief Fund. The work of these kitchens supplemented most usefully that of the dispensaries and was very much appreciated.

Treatment by Estates.—Under the Medical Wants Ordinance, tea and rubber estates maintain estate dispensaries for the treatment of minor ailments among their resident labourers and some estates or groups of estates have their own small hospitals. When violent outbreaks of malaria began to occur in villages near estates, many Estate Superintendents at once threw open their dispensaries for the treatment of villagers and in some instances they made house to house visits in the villages and with their dispensers treated the sick in their homes. This work was started in the very early days of the epidemic and was kept up in each district for so long as it was necessary. Provincial Surgeons were authorized to make free issues of quinine to estates for the treatment of village patients (Appendix 10), and 570 lb. of quinine were issued to 136 estates up to April 30. A number of estates also converted disused factories or other buildings into temporary hospitals for the treatment of villagers suffering from malaria and these hospitals were mostly conducted on the same principles and received the same assistance from Government as the temporary hospitals to be described in the next paragraph.

This brief reference to the help given by estates is a very inadequate acknowledgment of the prompt and vigorous action taken by many Superintendents in the estate districts of the epidemic area, or of the widespread medical assistance they rendered.

Voluntary Hospitals and Convalescent Homes.—The Department has information of forty-three voluntary hospitals or convalescent homes which were visited by its medical officers or apothecaries, or to which it supplied drugs. Most of them were situated in the Kandy, Kurunegala, Kegalla, and Matale Districts. One of the first to be started was the Colombo Convalescent Hospital organized by members of the Ceylon Social Service League and other voluntary workers and opened on January 2. This hospital provided accommodation for 120 convalescent malaria patients from the General Hospital and served to relieve very materially the congestion there. It was equipped and maintained almost entirely by contributions in kind or money from the public and was housed in very suitable buildings lent by the Colombo Municipality. It was a most satisfactory institution, and as regards equipment, management, and careful nursing served as a model for similar hospitals elsewhere. It was closed at the beginning of March.

Similar though rather smaller convalescent homes which attained a very satisfactory standard were opened at Gampola by the Urban District Council on January 21, at Matale by the local Social Service League on January 23, and at Kandy by the District Nursing Association on February 7. The Matale and Gampola Homes were closed towards the end of March, but the Kandy Home became indispensable when the secondary rise of malaria set in, and was eventually converted into a hospital. A well arranged and carefully conducted convalescent home of 50 beds which received convalescent patients from the Kurunegala hospital was started at Mallawapitiya on March 4, and continued to function after most other voluntary hospitals in the district were closed.

The cost of dieting these institutions was met largely by the Government Agent of the Province from the Malaria Relief Fund, while the Department provided the necessary drugs and usually the medical supervision.

A hospital of a different type was opened at Galagedara on January 4. It served a very malarious area, was accommodated in the local school and was managed by the school teachers with money supplied by the Government Agent, Central Province. As it was near the Government dispensary, treatment was conveniently supervised by the District Medical Officer and his apothecary. The hospital provided accommodation for 80 patients, mostly women and children, and by the end of April there had been nearly 1,200 admissions, 4 deaths, and 81 serious cases transferred to Kandy hospital, twelve miles away. A number of hospitals of this type were opened in places far from any Government hospital and proved of great service.

In the Matale District three or four very useful small hospitals for women and children were started in school buildings in inaccessible places such as Dullewa and Akuramboda. They were simply but efficiently equipped and organized by a lady doctor from Colombo and received the usual medical visit and drugs from the Department and financial help from the Assistant Government Agent, Matale.

A well run voluntary hospital, which served a difficult area, was that opened at the end of February at Yalegoda and which continued to function long after the secondary rise of malaria occurred in April.

A popular hospital was that opened by the All-Ceylon Buddhist Congress at Kehelwatta, eight miles from Kegalla. Although it was not in charge of a qualified medical man and was conducted in a rather primitive way a great number of patients were treated there and it was much appreciated by the villagers.

As already mentioned, a number of Estate Superintendents opened hospitals on their estates or took the initiative in starting hospitals in the neighbourhood for the villagers of the area.

It quickly became evident that the sanitary arrangements at the temporary hospitals, whether Government or voluntary, required very careful arrangement and supervision if dangerous conditions were to be avoided, and for this reason the Department through its Medical Officers of Health undertook the installation of latrines. At the same time it was noticed that many of the temporary hospitals and convalescent homes were deficient in other respects and certain minimum standards were laid down by the Department and were incorporated by the Commissioner for Relief into a circular letter setting out the conditions with which compliance was necessary if Government assistance was to be granted (*Appendix 11*). Before the end of April the majority of the voluntary hospitals had closed, but two or three were taken over by the Department, and a few remained open until a much later date and continued to give valuable service.

Miscellaneous Activities.—The transport of sick persons from their homes to hospital often presented serious difficulties. The majority of patients either walked to the dispensary or hospital or travelled in their slow moving bullock carts or by motor bus, and seriously ill patients were frequently carried to hospital in litters or stretchers by their relatives and neighbours (*Photographs 11 and 12*). Village headmen, sanitary inspectors, and the officers in charge of dispensaries and treatment centres all had authority to incur expenditure on Government account for the removal of the sick to hospital. But a great amount of very useful assistance was given voluntarily. Some of the large motor firms lent cars for work in badly affected village areas, motor bus proprietors in several districts conveyed patients free of charge to hospital or dispensary, a prominent resident at Kitulgala provided the Department with a motor bus for use as a travelling dispensary and for the conveyance of patients, and social workers from the towns visited the surrounding villages and brought in bad cases either in their own cars or in cars borrowed for the purpose.

Some of the voluntary hospitals were opened with poor or insufficient equipment and with no patients clothing. To meet this need a number of Colombo ladies belonging to the Wives' Fellowship made and supplied some 5,000 garments and other items of hospital equipment.

In the Kegalla District where child mortality was very heavy, a few of the ladies resident there opened centres for the distribution of milk foods and cod liver oil to babies and children of pre-school age. The children also received treatment for malaria and minor ailments.

(*c*) *General Relief.*—The economic condition in the epidemic area was not worse than usual at the start of the outbreak except in the North-Western Province and places in the northern part of the Kegalla District where drought and a caterpillar pest had seriously damaged the paddy crop, but it was evident that the combination of malaria and drought would produce serious distress in many parts of the affected districts and that food shortage would result. Early in December the Medical Department made it clear to Government that the two measures of primary importance were mass treatment with quinine and the supply of food where destitution and malaria co-existed. Mass treatment was obviously the function of the Department and suggestions were made that the Department should also undertake the necessary relief measures since its officers were in direct touch with the sick. It was pointed out, however, that relief should not be dependent on sickness, but that in any area where there was serious food shortage, food should be given to the healthy as well as to the sick in order as far as possible to maintain general health and to prevent the high mortality which occurs when epidemic malaria attacks a starving community. Further, it would have been an impossible task for officers who were already overburdened in their own sphere of work to undertake relief measures, and it would not have been desirable to encourage people to come for medicine merely in order to obtain food. The Department, however, kept in touch with the Government Agents and Assistant Government Agents of the Provinces and its Medical Officers, Apothecaries, and Sanitary Inspectors provided information as to when and where the free distribution of food appeared to be needed (*Appendices 5 and 6*).

In the second week in December the State Council approved the formation of a Malaria Relief Fund to which both Government and the public contributed. At first the Ministry of Labour, Industry and Commerce was responsible for relief, and distributions from the fund to Government Agents and Assistant Government Agents to meet the needs of their respective areas were approved by a committee consisting of the Deputy Financial Secretary, the Controller of Labour, and the Director of Medical and Sanitary Services. Government Agents arranged local Relief Committees which were composed of headmen and other officials together with representative non-official residents of the areas. The Relief Committees received supplies of food, chiefly rice from the Government Agent or his Assistant and were responsible for the proper distribution of the food to necessitous villagers either at distribution centres or by house to house visitation. At the start of the epidemic and for some months afterwards until the Government arrangements were fully organized much help was given by voluntary efforts.

A valuable measure, started in February, was the giving of a free midday meal to children at schools in bad areas. It resulted in an immediate improvement in the school attendance and in fact enabled many schools to reopen (*Appendix 12*). On January 21, 1935, a Commissioner for Relief under the Minister of Home Affairs was appointed and a separate report will be published by him.

3. Anti-Mosquito Measures.

Owing to the scanty December rains (Section III. 2) the rivers in January were again providing favourable conditions for the breeding of *A.culicifacies* and the observations of the Medical Entomologist's field staff showed that the larvae of this mosquito were to be found in considerable numbers in the beds of the Maha-oya, Deduru-oya, and Kelani-ganga.

The Department, while realizing that anti-larval measures even on a very large scale were unlikely to influence appreciably the course of the epidemic, thought it possible that in selected areas where the population was large these measures might help to prevent local outbreaks at a later date (*Appendix 3*). Under the circumstances it would have been an impossible task to control Anopheline breeding in some six or seven thousand miles of rivers and streams within the epidemic area, as well as in numerous subsidiary breeding places which formed after every heavy fall of rain. It was, therefore, decided (*a*) to oil selected lengths of the main rivers and their tributaries on notification by the Medical Entomologist of *culicifacies* breeding and to place the Sanitary Engineer in charge of this work; (*b*) to undertake with village labour under the supervision of sanitary inspectors, minor measures for the elimination of subsidiary breeding places and to make the Medical Officers of Health responsible for the organization and control of the work; (*c*) to co-operate with the Colombo Municipality in protecting the city against malaria by controlling intensively the *culicifacies* breeding places beyond the Municipal boundaries while the Medical Officer of Health, Colombo, took similar measures within the Municipal area, and to put the Superintendent, Anti-Malaria Campaign, in charge of the Department's share of the work; and (*d*) to obtain by means of regulations the necessary legal powers to carry out anti-mosquito measures.

The first river to be oiled was the Maha-oya (*Map No. 9*). Work began on January 19, over a selected stretch of 33 miles—from a mile above Mawanella bridge to a mile below Giriulla bridge. Near this part of the river are Mawanella, Rambukkana, Polgahawela, Alawwa, Ambepussa, Dambadeniya, and Mirigama, all places which had been heavily infected from the onset of the epidemic. An Assistant Sanitary Engineer was put in charge of the operations with a temporary staff of overseers and locally recruited labour; a number of trained oilers were withdrawn from their permanent stations to help to train the recruits. An entomological field assistant worked in close co-operation with the engineer and kept a constant check on the efficiency of the oiling work. The labourers worked in two gangs each under an overseer, one gang taking the upper length of the river from Mawanella to Rambukkana and the other the lower length from Rambukkana to Giriulla. In each party, five labourers were employed in spraying and twenty in minor canalisation and filling pools. The oil (Shell anti-malaria mixture) was delivered in 64 gallon drums from the road petrol station nearest the work in progress and was then decanted into 4 gallon drums for easy transport along the river. The average width of the river bed was 300 feet and each gang dealt with five or six miles a day of the main river and its tributaries (*Photographs 13, 14, and 15*). 640 gallons of oil were used during the first oiling which took a week to complete. On January 30, two and a half inches of rain fell and the river was flowing and turbid for the next few days, after which pools re-formed and oiling began again on February 7.

While the work on the Maha-oya was in progress other mobile oiling squads were being formed, equipped and trained to undertake anti-larval operations on the Kelani-ganga, Mahaweli-ganga and Deduru-oya and their branches, and oil depots were being established at convenient points. By February 1, five additional oiling parties were ready, but the rivers were flowing after the recent rains and it was some days before these parties were posted to their stations. By February 12, in addition to the Maha-oya, selected portions of the Talatu-oya, Kudu-oya, Delwita-oya, Sitawaka-oya and Deduru-oya were being oiled. By the middle of February, twelve permanent and five temporary Entomological Assistants were in the field, the number of oiling gangs had been increased to ten, and work on certain parts of the Kelani-ganga had been commenced under the direction of an Assistant Sanitary Engineer stationed at Avissawella.

Mr. H. N. Worth reporting on this work states:—" It was obvious with so large an area to cover and the innumerable rivers and streams to be put under control from time to time that an accurate method of recording progress was of the first importance. A scheme was devised whereby the results of the entomological findings could be quickly recorded and the field staff immediately notified as to new sections to be taken up, &c. The method adopted was as follows:—Topographical sheets of one inch to the mile covering the whole of the affected area were obtained from the Survey Department. These sheets were then grilled into one mile squares by black lines and index numbers and letters shown on the lower and left hand margins respectively of each sheet. The sheets were given distinctive numbers and mounted on cloth. Copies covering their particular area were issued to the field staff—Assistant Engineers and Entomological Assistants—and a complete set for daily recording purposes was maintained in the Sanitary Engineer's Office. Recording was carried out by inserting coloured pins into these maps which gave the following information:—Headquarter stations, Overseers' headquarters, boundaries of sections, oil depots, sections under observation and those taken in hand, dangerous brick pit or quarry areas receiving treatment, areas examined but not recommended for treatment and sections of oiling stopped due to local rains or absence of Anopheline breeding. In addition, records were kept of the quantities of oil used on sections, the distribution of oiling equipment and the stocks of oil held at the various points within the area.

Bi-monthly reports were sent by the Assistant Sanitary Engineers giving the particulars of each section of river, the time required to deal with it by the oiling gangs and the oil and labour involved.

The Entomological Assistants forwarded a copy of their observations direct to the Assistant Engineers in the field who when necessary put additional work in hand without further reference. Duplicate records were also sent to the Medical Entomologist who after studying the findings advised accordingly.

The efficiency of the oiling operations were subsequently checked by the entomological staff.

By March 22 approximately 275 miles of rivers and streams were being systematically oiled weekly. Work on certain sections was stopped from time to time for short periods on account of local rain, and other sections were abandoned when *A.culicifacies* breeding was no longer detected.

The quantity of oil used amounted to 8,800 gallons. Approximately 15 gallons of oil were required per mile of river bed for each application, but this amount varied with the width and nature of the river. The number of knapsack sprayers in use was between 75 and 80. The average width of the Maha-oya river bed is 300 feet.

Owing to the heavy nature of the undergrowth and debris in certain sections of the rivers it was found impossible for the oiling gangs to work through these sections rapidly until some clearing had been done. In order to overcome the delay in clearing long stretches of water-courses it was decided to treat such sections temporarily with Paris green in lieu of oil and so allow a large number of oil sprayers to be released for additional open sections and for the stock of Paris green equipment to be brought into use. The work of mixing Paris green with soapstone as a diluent was carried out under the supervision of the Sanitary Engineer's staff in a shed at Maradana kindly lent by the General Manager of the Railways ".

The rains at the end of March and beginning of April put a stop to the work for a short time, but before the end of April anti-larval measures were again being applied to selected parts of the four main rivers and of sixty-nine of their tributaries, and a total length of 314 miles was under weekly control.

The attempt to deal with subsidiary breeding places in village areas started towards the end of January. Medical Officers of Health were instructed to initiate schemes in their districts, to supply the Sanitary Inspectors or temporary Assistant Sanitary Inspectors needed for the supervision of the work and to arrange with revenue officers for the recruitment and payment of village labourers. The measures adopted were such as did not require trained or skilled labour and consisted principally of filling or draining pools, clearing and canalising streams and generally cleaning up the areas dealt with. Appendices 13 (*a*) and (*b*) give in detail the scope of the work and define the duties of the temporary Sanitary Inspectors of whom 299 were employed for varying periods. In the districts of the Medical Officers of Health, Chilaw, Gampaha, Kegalla, Kandy, Kurunegala, Matale, Negombo, and Panadure work was quickly started and in most instances was well organized.

When malaria infections were found to be taking place in Colombo, the Acting Medical Entomologist, in consultation with the Medical Officer of Health, Colombo, arranged a thorough entomological survey in and around the city, and after the discovery of *A.culicifacies* breeding (*Map No. 16*) the Department undertook to co-operate with the Municipality in protecting Colombo by means of intensive anti-larval measures. Inside the city these measures were carried out by the Municipal anti-mosquito gangs under the direction of the Medical Officer of Health and outside the Municipal limits the work was paid for by the Department and was organized and controlled by the Superintendent, Anti-malaria Campaign.

At the onset of the epidemic there were no statutory powers providing for the enforcement or carrying out of anti-mosquito measures. Colonel S. P. James (1914) after his mosquito survey of Colombo in 1912 and 1913 put forward clear and definite reasons for the enactment of anti-mosquito legislation and subsequently several unsuccessful attempts were made to introduce an Ordinance. The Bill (*Appendix 14*) rejected by the State Council in 1933 had been under consideration for twelve years and during that time had passed through the hands of so many committees and had been so often amended with a view to preventing " harsh " measures being applied to anyone under any circumstances, however much the public health might be at danger, that had it become law it would have been a feeble weapon with which to meet epidemic conditions.

Legal powers were, however, necessary in order to give officers of the Department the right of entry to private property for the purpose of inspection and for carrying out measures to control Anopheline breeding. Simple and short regulations under the Quarantine and Prevention of Diseases Ordinance, 1897, were, therefore, drafted and after approval by the Executive Committee of Health were submitted to His Excellency the Governor and were gazetted on February 8, as " The Malaria (Epidemic) Regulations, 1935 " (*Appendix 15*). The Regulations have proved useful and have enabled anti-larval measures to be undertaken. Their application has not caused hardship or been resisted by the population and no prosecution under them has been entered.

With regard to the value of the anti-larval measures taken, the view is held that in the case of Colombo the application of these measures was logical and sound. A population of nearly 300,000 persons living in a well defined area was at risk, the number and extent of the breeding places of *A.culicifacies* were small and a trained personnel was available to carry out intensive and efficient control. When the secondary rise in the malaria incidence occurred in April no new infections were reported in Colombo.

The work undertaken in the villages is in contrast with that done in Colombo and was perhaps of little direct value as an anti-malarial measure.

The value of the work done on the rivers is more difficult to assess. As the oiling was done after the actual detection of *A.culicifacies* breeding it is fair to assume that considerable destruction of larvae resulted and that there was a consequent diminution in the number of *imagines*. On the other hand the secondary rise of malaria which started in April was greater near the stretches of the Maha-oya which had been carefully oiled since the third week of January than in any other part of the epidemic area (*Chart 4*).

In the wet zone of Ceylon anti-larval measures in any particular river basin may not be indicated for months or years at a time, but when they are indicated they will be required so quickly and over so extensive an area that it would be difficult to apply them efficiently. Anti-larval measures to have influenced the present epidemic would have needed to start in August or September, 1934, and should have been instituted over the whole epidemic area. The practical impossibility of adopting such a proceeding in anticipation of an uncertain event need not be stressed.

SECTION VI.

PREVIOUS EPIDEMICS OF MALARIA.

Historical References.

Although the early history of disease and epidemics in Ceylon is a matter of conjecture, there seems little doubt that malaria has been prevalent in the Island for centuries. Father Queyroz, writing in 1687 alludes to the ancient court of Anuradhapura as being " abandoned on account of a protracted pestilence ". (*Perera 1930.*) Earlier he speaks of the disease being " the plague of these nations and warm climates, where it attacks the same person two or three times ". The " disease " has been translated as " smallpox " which is obviously incorrect since successive attacks of smallpox do not occur. Nicholls (1921) is also of the opinion that the primary cause of the ruin of the ancient civilization of Ceylon was due to the introduction of malaria from India.* Others suggest that the work of destruction started by the Tamil invasion, was completed by the introduction of malaria which made it impossible for these parts to recover prosperity.

Knox (1681) in writing an account of his captivity in Ceylon alludes to the exceptional prevalence of fever in a town 30 miles north of Kandy. " The first year we were brought into this town, this part of the land was sickly by Agues and Feavours, whereof many people dyed; insomuch that many times we were forced to remain an hungry, there being none well enough either to boil or bring victuals unto us ".

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* There is a primitive map of Ceylon among the Government archives, it was published in 1638 by the Dutch. The area of the old kingdom of Yala in the Southern Province is marked with the statement " this was depopulated and deserted 300 years ago by fever sickness ". Also the North-Central Province is marked " depopulated by sickness ".

Photograph 13.

ANTI-ANOPHELINE WORK ON THE MAHA-OYA RIVER (JANUARY 19, 1935).

Photograph 14.

OILING WORK IN KOSPOTU-OYA, KURUNEGALA (FEBRUARY 20, 1935).

Photograph 15.

CANALISING AND OILING OF KOSPOTU-OYA (FEBRUARY 20, 1935).

In 1765, the Dutch reported that sickness was raging in Kandy and at some of the outposts "principally at Gonewile, sickness is raging severely among the men. God forbid that it should continue any longer or grow worse!" (Extract from letter dated April 6, 1765. Journal Roy. As. Soc., Ceylon 1901).

The following extract from the Dutch Minutes of Council of Friday, June 1, 1787, is of interest:—

> "Consideration having been paid to the fact that fever prevails in general among the inhabitants of the Colombo Disawany* and that they suffer great hardship owing to their inability thereby to cultivate their gardens and fields: it was accordingly found good and resolved that so long as this extraordinary condition of sickness prevails, the Mudaliyars and chiefs in the Korles should be authorized to issue to those in need living in the country quantities of the Company's paddy to be returned by them later; and whereas information has been received that similar sickness also prevails in the Galle Korle and the Matara Disawany, it has been resolved to authorize the officers at Galle and Matara to issue the necessary quantities of paddy to the inhabitants of the Galle Korle and the Matara Disawany through the Mudaliyars and chiefs of the Korles, to be similarly returned by them."

Davy (1821) referred to districts of the interior of Ceylon being "suddenly desolated by endemic fever". He thought intermittent fevers most commonly attacked the natives and remittent fever the Europeans.

Marshall (1846) who was Assistant Surgeon to the English troops observed that endemic fever was one of the prevailing diseases in Ceylon, both among the emigrants from Europe and the indigenous inhabitants.

Hirsch (1883) referred to Ceylon as one of the headquarters of severe remittent and pernicious malarial fever.

1. Epidemics before 1900.

The first Ordinance for the registration of deaths in Ceylon (No. 13 of 1862) came into operation in 1867, and the first regular census of the population was taken in 1871. Registration of deaths was optional prior to 1897 when an Ordinance was introduced making registration of deaths compulsory throughout the Island. Data relating to deaths were undoubtedly imperfect before registration was enforced so that no satisfactory comparison can be made between the mortality figures of epidemics in the 19th century. That severe malaria epidemics occurred is evident from a study of the early administration reports though epidemics of cholera are dealt with in greater detail and appear to have been more frequent.

In 1858 the Ceylon Government created a Civil Medical Department. In 1867, the earliest available report of this Department, reference is made to an unusual prevalence of fever in the Eastern Province, and in the west among coolies working on bridges over rivers, the beds of which were dry at the time. "Malaria fever rapidly prostrated them and in the case of the Deduru-oya the work was obliged to be abandoned". The cause was attributed to unhealthy emanations from beds of the rivers. In 1868 fever is again mentioned as being extremely prevalent throughout the most thickly populated portions of the Island".

The next reference to an outbreak of malaria is in 1877. The epidemic occurred in the country drained by the Kelani-ganga and the Kalu-ganga after the floods had subsided in May and continued till November. The fever was of the intermittent type and the sequelae were debility, anaemia, enlarged spleen, diarrhoea, dysentery, jaundice and dropsy. Extensive outbreaks occurred in Negombo and Kegalla. Malarial fevers prevailed extensively in the Kurunegala and Puttalam Districts and also from Avissawella to Ratnapura. It is reported that mortality was slight although large numbers were attacked. The epidemic was attributed to the "decomposition of organic matter left exposed to the sun after the floods".

In 1880 special mention is made of outbreaks of fever in Negombo, Ratnapura, Kurunegala and parts of Kandy and Matale Districts which occurred towards the end of the year after the heavy rains of the north-east monsoon. Kurunegala, where it is stated the rains followed a prolonged drought, was specially affected. In Kalutara, intermittent fever prevailed in Pasdun Korale from March to October and was attributed to the clearing of jungle for cultivating coffee. The epidemic did not abate in Kurunegala and Negombo until the early part of the following year.

In 1884 malaria again appeared in epidemic form in Negombo District and in many villages of Ratnapura, Kegalla, Putalam and Kurunegala. It was attributed to the severe and prolonged drought followed by the continuous rains of the north-east monsoon. Increased prevalence of malaria was also reported between Matale and Anuradhapura and in the Eastern Province.

In 1887, 1888, and 1889 fever prevailed extensively. In 1887 an epidemic started during the south-west monsoon in parts of the Western and North-Western Provinces. The Kelani Valley, Negombo, and Chilaw Districts were specially affected. About a dozen itinerating Medical Officers were sent to the fever-stricken districts. The epidemic in Kalutara was attributed to the "decomposition of felled jungle after the heavy rains". An extensive outbreak also occurred in Galle in the early part of the year, and at the end of the year an epidemic was reported in the Northern Province, which appears to have continued until March, 1888. Matale and Galagedera are specially mentioned as having a recrudescence in 1888. In 1889 there were severe epidemics at the beginning of the year in Batticaloa and Jaffna. In Jaffna, fourteen medical men were employed for house to house visitation; 6,035 cases were reported and thirty-seven deaths but these figures are stated to be too low. A very large number of cases were also reported in Uva Province and there was much distress.

In 1891 severe outbreaks of malaria fever were reported in January in the North-Western, Southern, Sabaragamuwa and Uva Provinces. The epidemic appears to have subsided in these areas in March. In March an outbreak of fever occurred in the Eastern Province, the Western, Central and North-Central Provinces were affected during May and June. Fever of a severe type prevailed in Alutkuru Korale North in the Negombo District during May. The Northern Province had an increased prevalence of fever in August. Medical Officers were despatched to the affected areas to " afford medical relief to the sufferers ". The epidemic in the Northern and Eastern Provinces was attributed to " the cyclone at the end of the preceding year ".

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* This area extended from Chilaw down to the Walawe river, Matara.

In 1892 a severe epidemic was reported to bave begun in the last quarter of the year in the Western, North-Western and Sabaragamuwa Provinces. It increased in intensity during the first quarter of 1893 and gradually subsided in July and August. The outbreak was attributed to a long continued drought followed by rain.

In 1894 an epidemic again occurred in the Western Province beginning in April. In May a severe form of malaria was reported in Negombo and Ja-ela. Villages bordering the Kelani Valley were next affected. From April to September there were severe outbreaks in Sabaragamuwa Province attributed to " the opening of tea estates on new land in the district aggravated by scarcity of food and bad water from long continued drought ". Three medical assistants itinerated the district. The Principal Civil Medical Officer (Sir William Kynsey) noted in his report: " Mortality caused by malarial fevers and their sequelae is enormous and I fear is increasing yearly ". The following year, 1895, fever was again very prevalent. During the early part of the year outbreaks occurred in the Western Province but the outstanding epidemic of the year was the virulent outbreak in Galle and Matara Districts. It began in July at Galle and continued till November. Many deaths occurred; several medical practitioners were engaged and two temporary hospitals and two dispensaries were opened. In November a severe type of malaria began in Matara and lasted till July the following year. The cause was attributed to the disturbance of the soil when cutting the railway from Galle to Matara.

The next malaria epidemic of note occurred in 1898 in Jaffna. It was reported to be very virulent and started during the heavy rains of November and December. Distress was great and mortality high. The outbreak was regarded as one of the severest known in the District. Matale and Kurunegala also had a severe epidemic during the year which was attributed to the prolonged drought. Malaria appeared to have been generally prevalent and the incidence high in most provinces during 1898 but of a mild type except in Jaffna, Matale and Kurunegala.

The virulent epidemic in Jaffna did not subside until March in the following year, (1899) and there was a recrudescence again in November. Malaria was also reported to be particularly severe in Trincomalee and the Eastern Province during the first and second quarters of this year.

2. Epidemics since 1900.

Chart 8 shows the trend of mortality in Ceylon since 1900. During the last thirty-five years the rate has never been less than 20 per 1,000 population and in some years it has exceeded 30 per 1,000. The years of excessive mortality were 1906, 1911, 1914, 1919 and 1923. From 1923 to 1927 there was a downward trend in the death rate. During the next two years 1928 and 1929, mortality increased followed by a decline until 1934.

With the exception of 1919, when the severe epidemic of influenza which affected the whole world was responsible for the high death rate, the peaks of mortality since 1900 have been mainly caused by outbreaks of malaria.

Epidemic of 1906.—The epidemic of 1906 occurred during April to September following a long period of drought. Rainfall had been deficient in 1905 and continued deficient for the first three quarters of 1906. The epidemic appears to have been fairly general throughout the Island except in the Northern Province.

Perry (1906) gives a very concise account of the outbreak. " A wide-spread outbreak of malaria occurred from April to September throughout the Island, the only province which shows a less number of cases than during the previous year was the Northern. In some parts of the country there was scarcely an inhabitant who was not suffering from this disease, and the distress was very great. The districts which were most seriously affected were Matara, Hambantota, Veyangoda, Hanwella, the Kelani Valley, Matale, Teldeniya, Buttala and Muppane, a large portion of the North-Western Province and nearly the whole of the Province of Sabaragamuwa. It was noticed that in those parts of the country where large tracts of land were being cleared for the extension of rubber cultivation, there the fever was most virulent and widely prevalent. In Government hospitals and dispensaries 700,541 persons were treated for malarial fever, in addition to which were the cases treated at estate dispensaries, in jails, and by persons specially engaged to distribute quinine to those suffering in remote villages, and to many private individuals who undertook to distribute remedies for the sake of charity ".

A short sessional report on the epidemic in the low-country (*Appendix 16*) was published in July, 1906, giving an account of the steps taken to cope with the abnormal amount of sickness. The report states that in the provinces chiefly affected, viz., Western, Central, Sabaragamuwa, parts of North-Western and a small part of the Southern, there were 178 hospitals and Government dispensaries and 97 estate dispensaries totalling 275 medical institutions where medicine was supplied and the sick treated. In addition 29 persons were employed on itinerating duty to distribute quinine to patients unable to attend dispensaries. Quinine and other medicine was also supplied free to voluntary workers for distribution.

The total amount of quinine issued from January to July was 3,043½ lb. as against 2,036 lb. during the same period in the previous year.

Some of the hospitals became overcrowded and temporary ward accommodation was asked for at Panadure, Avissawella, Kegalla, Ratnapura, Balangoda, Lunugala, Nawalapitiya, and Teldeniya and more permanent wards for Matale and Kurunegala.

In the January following the epidemic, a severe outbreak occurred at Hambantota and 2,591 deaths were recorded in January and February alone. In the previous June and July when the 1906 epidemic was at its height there were 896 deaths.

In 1906 the death rate for the whole Island rose to 35.1 per 1,000 as compared with 27.4 the average for 1900-1905 (*Table 29*). In actual numbers 136,271 deaths were registered in 1906 as against an average of 99,592 for 1900-1905 giving an increase of 36,679 deaths in 1906. Table 29 shows that mortality was particularly heavy in Kurunegala, Ratnapura, Matale, Matara, Hambantota, and Kegalla Districts. The peak of the epidemic as regards mortality was reached in July when 14,072 deaths were registered.

TABLE 29.

Comparison of Mortality in Provinces and Districts during Epidemic Years of 1906 and 1911.

Province or District.	1906.				1911.			
	Deaths per 1,000 persons living.			Per cent. increase in 1906 as compared with 1898–1905.	Deaths per 1,000 persons living.			Per cent. increase in 1911 as compared with 1898–1908.
	Average 1898–1905.	1906.	1907.		*Average 1898–1908.*	1911.	1912.	
Western Province	*22.1*	29.3	24.3	+ 33.0	*23.2*	28.6	24.6	+ 23.2
Central Province	*28.1*	37.3	28.0	+ 32.7	*29.3*	35.4	31.3	+ 20.8
Northern Province	*31.0*	29.1	33.1	— 6.1	*30.8*	24.7	35.6	— 19.8
Southern Province	*24.4*	33.6	37.5	+ 37.7	*27.0*	32.2	35.7	+ 19.3
Eastern Province	*32.2*	31.9	36.1	— .9	*32.1*	29.9	32.9	— 6.9
North-Western	*30.9*	47.5	33.1	+ 53.7	*32.9*	39.4	35.7	+ 19.7
North-Central	*41.7*	43.9	47.8	+ 5.2	*42.1*	33.0	54.5	— 21.6
Uva	*36.2*	45.8	39.1	+ 26.5	*37.9*	37.1	37.4	— 2.1
Sabaragamuwa	*30.0*	45.0	34.8	+ 50.0	*32.5*	59.0	40.2	+ 81.5
W. P. Colombo	*22.7*	30.3	24.8	+ 33.4	*24.0*	28.9	24.5	+ 20.4
Negombo	*18.8*	27.3	17.5	+ 45.2	*19.4*	32.9	23.4	+ 69.5
Kalutara	*22.9*	28.4	27.5	+ 24.0	*24.0*	25.3	25.7	+ 5.4
C. P. Kandy	*28.6*	36.1	27.1	+ 26.2	*29.3*	34.5	30.9	+ 17.7
Matale	*36.2*	57.8	33.1	+ 59.7	*39.0*	49.1	41.2	+ 25.9
Nuwara Eliya	*21.6*	27.9	27.0	+ 29.2	*23.1*	28.3	25.6	+ 22.5
N. P. Jaffna	*29.4*	27.2	30.5	— 6.9	*28.9*	23.0	33.0	— 20.4
Mannar	*44.5*	45.7	50.8	+ 2.7	*45.2*	37.0	51.1	— 18.1
Mullaittivu	*42.6*	42.5	60.8	— .2	*44.6*	38.6	64.4	— 13.5
S. P. Galle	*24.8*	26.5	31.0	+ 6.8	*25.7*	26.3	27.4	+ 2.3
Matara	*23.3*	34.1	33.0	+ 46.3	*25.7*	32.1	34.8	+ 24.9
Hambantota	*23.5*	50.4	63.3	+ 97.7	*33.0*	53.9	60.5	+ 63.3
E. P. Batticaloa	*31.6*	33.4	35.8	+ 5.7	*31.6*	29.7	30.9	— 6.0
Trincomalee	*35.3*	28.6	37.7	— 19.0	*35.2*	31.4	43.6	— 10.8
N.-W. P. Kurunegala	*33.3*	53.9	35.8	+ 61.9	*35.8*	43.0	38.4	+ 20.1
Puttalam	*38.2*	45.1	43.5	+ 18.0	*39.5*	32.5	31.1	— 17.7
Chilaw	*19.4*	27.1	20.6	+ 39.7	*20.3*	29.8	27.7	+ 46.8
N.-C. P., Anuradhapura	*41.7*	43.9	47.8	+ 5.3	*42.1*	33.0	54.5	— 21.6
Uva Badulla	*36.2*	45.8	39.1	+ 26.5	*37.9*	37.1	37.4	— 2.1
Sab. Ratnapura	*32.2*	52.4	43.7	+ 62.7	*36.5*	51.3	43.2	+ 40.6
Kegalla	*28.2*	40.1	28.9	+ 42.2	*29.8*	64.3	38.1	+115.7
Ceylon	*27.4*	35.1	30.1	+ 25.2	*28.5*	34.8	32.4	+ 22.1

Epidemic of 1911.—The epidemic occurred between May and August after the break of the south-west monsoon following a prolonged drought. The outbreak appears to have been confined to parts of the Western, Sabaragamuwa, and Central Provinces. During the twelve months 869,369 persons were treated for malaria in hospitals and dispensaries in the whole Island, an increase of 23,675 in proportion to the number treated in the preceding 18 months. In Kegalla it was reported that about 50 per cent. of the entire population was prostrated " causing numerous deaths and reducing the poorer classes to the verge of distress. To combat the disease two itinerating apothecaries were appointed and quinine was freely distributed both through the headmen and by means of itinerating distributors ". In Matale the epidemic was reported to be widespread and severe. The hospital staff had to be strengthened and itinerating dispensers toured the villages.

The death rate for the whole Island was rather less than in the 1906 outbreak, 34.8 in 1911 against 35.9 in 1906. In actual numbers 143,380 deaths were registered in 1911 as against an average of 110,347 in 1901-10 giving an increase of 33,033 deaths in 1911.

Table 29 shows that mortality was highest in Kegalla District, 64.3 per 1,000, while in Ratnapura, Hambantota, Matale, and Kurunegala Districts a death rate of over 40 per 1,000 was recorded. The peak of mortality was reached in August when a total of 15,655 deaths were recorded for the whole Island. A severe recrudescence occurred early in the following year and deaths rose from 12,874 in December, 1911, to 17,758 in January, 1912.

The district most seriously affected in 1912 was Hambantota, where a virulent type of malaria was reported, and there was widespread distress; 6,806 deaths were registered during the year giving a death rate of 60.5. In Kegalla " a fever epidemic spread over the district in the early part of the year and was most severely felt in the valley of the Maha-oya always an unhealthy locality . . . . Medicine distributors were appointed . . . . In Galboda and Kinigoda korales, however, Government was obliged to spend Rs. 203.52 in feeding the villagers most severely affected, their condition rendering relief work out of the question ". In the Central Province the recrudescence was chiefly felt in Yatinuwara. In Matale the outbreak was reported to be particularly severe. It was estimated about 40,000 cases of malaria were treated at the hospitals and dispensaries but only a small proportion of the total cases came to the dispensaries for treatment. Prophylactic measures taken were the distribution of quinine and pamphlets.

In 1913 Matale was again seriously affected. " The heavy rains of the north-east monsoon, following as they did immediately on the severe drought, resulted in one of the worst outbreaks of malarial fever which the district has known for very many years."

Epidemic of 1914.—During the early part of 1914 the Eastern and Uva Provinces appear to have suffered from an epidemic of malaria. In the Eastern Province it was reported that 88,736 cases occurred as compared with 47,699 in the previous year. In Manmunai pattu a special officer was detailed to distribute quinine owing to the abnormal severity of the outbreak.

In Uva Province, malaria was extremely prevalent and a severe type occurred in Badulla town.

The death rate for the whole Island was 32.2 per 1,000 as against 34.8 in 1911. The peak of the mortality occurred in January when 16,548 deaths were recorded as against 12,138 in the previous year.

Epidemic of 1923.—A severe outbreak occurred in Trincomalee District from January to May and infection was widespread. Kegalla also had a severe epidemic at the beginning of the year, the Three Korales being specially affected and 9,000 quinine powders were distributed to headmen during the year. (In the previous year Kegalla also had a widespread epidemic lasting from May to August.) It was attributed to the prolonged drought followed by insufficient rains and to pilgrims from Anuradhapura bringing in a particularly bad type of fever.

In the Eastern Province there was an outbreak at the end of the year in Karawaka pattu, Akkarai pattu, and Sammanturai. It was reported to have occurred after the rains following a long and exceptionally severe drought.

The number of deaths registered in 1923 was 141,891 or 30.6 per 1,000 population, an increase of 15,071 deaths as compared with 1922.

Epidemic of 1928-29.—The area affected by the epidemic at the beginning of 1928 was the North-Western Province, Uva, the lower part of the Kelani Valley in the Western Province, Kegalla in Sabaragamuwa Province. Later on in the year a severe epidemic occurred in the Central Province in Matale District in July and in Dumbara Valley in October. In the Southern Province the outbreak started at the end of the year in December in Tangalla and Hambantota. It was attributed to the heavy rains following a long and severe drought. In most areas it was reported to be the worst epidemic for several years. Kegalla was specially affected where the epidemic " continued with great severity till past the middle of 1928 ". During the year 14,787 lb. and 2,593,450 tablets of quinine were issued.

The total deaths for the whole Island numbered 132,334 or 26 per 1,000 population, an increase of 19,331 deaths as compared with the previous year.

Malaria was again very prevalent in 1929. Severe epidemics were reported in the North-Central, Northern, and Eastern Provinces in the early part of the year. Towards the end of the year epidemics occurred in the Western Province, particularly in the Gampaha and Avissawella areas, in the Central Province in the North Matale and Dumbara Valley and in the Southern Province. The death rate for the year was 26.1 per 1,000.

In 1930 the outbreak which started in November 1929 reached its height in February, 1930. It was reported to be " one of the most extensive and severe outbreaks of recent years ". The Southern, Northern, and Eastern Provinces were particularly affected. The death rate for the whole Island was 25.4 per 1,000.

SECTION VII.

SUMMARY.

An epidemic of malaria of greater magnitude than any previously recorded in Ceylon started in October, 1934. It reached its height at the end of the third week of December and was slowly subsiding until the second week of April, 1935; then an increase took place which affected the whole epidemic area and in many places continued until the beginning of June.

2. It is estimated that from October to the end of April about 1,500,000 persons contracted malaria in the epidemic area. During the six months, November, 1934 to April, 1935 inclusive, 92,556 deaths (from all causes) took place in the districts affected by the epidemic; this figure is 59,144 in excess of the previous four years' average for the same period.

3. In most districts outside the epidemic area there was much more sickness than usual during the period of the epidemic. The number of deaths in these districts for the six months, November to April, was 37,175, or 10,451 in excess of the " expected " number.

4. The area affected by the epidemic lies in the south-west quadrant or wet zone of Ceylon. It is approximately 5,800 square miles in extent and has a population of 3,100,000 persons. The remainder of Ceylon has an area of 19,500 square miles and a population of 2,450,000 persons.

5. The wet zone of Ceylon has an abundant rainfall throughout the year because it receives rain during both monsoon periods. Thus, its rivers are nearly always flowing and because of their continuous flow do not offer suitable conditions for Anopheline breeding. This zone therefore is comparatively free from malaria in normal times, and being the richest agricultural part of the Island supports the greater part of the population. Over the dry zones the rain falls principally during the north-east monsoon and there is a long period of comparative drought during the south-west monsoon; malaria is endemic in these zones and has a seasonal prevalence from November to February.

6. The year 1934, from April onwards, was an exceptionally dry year. During July, August, and September, the rainfall over the greater part of the wet zone was less than that recorded in any previous year. Only in the south (Galle and Matara Districts) was the rainfall during these months up to average and the two districts mentioned did not suffer from epidemic malaria. The failure of the rains of the south-west monsoon from April to September was followed by a failure of those of the north-east monsoon from November to the following March. The October rains were the only real interruption in the drought. The conditions produced by the prolonged drought in the larger rivers and their tributaries were of fundamental importance in connection with the epidemic.

7. Although there are eighteen known species of *Anopheles* in Ceylon, the only proved carrier of malaria in the Island is *A.culicifacies*. In normal years this mosquito is found principally in the dry zones. It occurs in the wet zone only in small numbers, since wet zone conditions are usually unfavourable for its development. Its favourite breeding places are shallow pools of clear, fresh water exposed to the sun.

8. The gradual drying up of the rivers in the wet zone from July onwards led to the formation of suitable breeding places over a very large extent of the river beds, and during the epidemic the larvae of *A.culicifacies* were found in these situations with a frequency and in numbers not previously recorded. It was in the beds of the main rivers and their larger tributaries rather than in the smaller streams that most of the *culicifacies* breeding took place. Wells, borrow pits and quarries provided subsidiary breeding places but were not of major importance. *A.culicifacies* larvae were obtained in largest numbers in river areas where the epidemic was most intense.

9. High infection rates were obtained among *A. culicifacies* caught in dwellings in the epidemic area. During December, 1934, the mean rate for the whole area was 12.9 per cent. In January and February, 1935, the rates were 3.1 and 1.9 respectively and in April 3.4. In the hyper-endemic areas of the dry zone to the north of the epidemic area the percentage of infected *A. culicifacies* was much lower.

10. The area of the epidemic was confined chiefly to the basins of five rivers—the Deduru-oya, Maha-oya, Kelani-ganga, Kalu-ganga, and Mahaweli-ganga. Malaria broke out early in October in villages in the middle reaches of the Maha-oya and invaded rapidly and with great intensity the regions drained by the upper and middle reaches of the Maha-oya and Deduru-oya (Kegalla and Kurunegala Districts). It was in these regions that the greatest proportion of the population was infected and that the highest mortality occurred. A little later the epidemic appeared in the Matale and Kandy Districts in the Mahaweli-ganga basin, and then, at the beginning of December, in the upper and middle areas of the Kelani river (southern part of Kegalla and eastern part of Colombo Districts). In the Mahaweli-ganga and Kelani-ganga basins the intensity of the epidemic was moderately severe, but it did not cause the same amount of devastation and suffering as in the Deduru-oya and Maha-oya basins. It finally invaded the Kalu-ganga basin (Ratnapura and Kalutara Districts) and the coast. The Ratnapura District was moderately affected and the Kalutara District only slightly. The coastal area south of the mouth of the Maha-oya is normally free from malaria, and infections occurred in a number of coastal towns (including Colombo) which for many years had been entirely malaria-free. Conditions generally were worst in the upper and middle reaches of the rivers, and the coastal districts, therefore, suffered much less than the corresponding inland districts.

11. While the out-patient attendances were greatest in December, mortality was greatest in January. In the epidemic districts the number of deaths in January was 27,518, an excess of 20,594 over the January average of the four previous years. In December in these districts, the excess was 8,195 and in February 13,619. In the Kegalla District mortality reached its peak in February when it was a little more than eight times the " expected ". In the Kurunegala, Matale, and Kandy Districts mortality was greatest in January when in these districts respectively it was nearly eight times, six times, and four times the " expected " number. The worst district outside the epidemic area was Anuradhapura where deaths in January were three times the " expected " number. The epidemic took a heavy toll of child life, the greatest number of deaths occurring in the age group under five years.

12. Throughout the epidemic the malaria was mainly benign tertian and subtertian. Quartan malaria was rare. From November to March inclusive, in the positive blood films examined, the three species of parasite occurred in the proportions of *P. vivax*, 62.2 per cent., *P. falciparum*, 36.7 per cent. and *P. malariae*, 1.1 per cent. The majority of the films were from hospital in-patients and if a more representative group of patients had been examined the proportion of *P. falciparum* would have been lower. The percentage of *P. falciparum* rose from 24.7 in November to 43.4 in January and then fell to 28 in March. The relative proportions of *P. vivax* and *P. falciparum* showed considerable variation in different areas.

13. From the clinical aspect, most of the cases were of the simple febrile type. They reacted readily to treatment, but relapses were frequent. Cases of cerebral malaria were almost always caused by subtertian infections and nearly one-third of them proved fatal. The algid type of the disease was less common; it was nearly always a subtertian infection and the case fatality rate was high. Dysentery and severe diarrhoeas, and pneumonia were the most important complications and more deaths were attributable to these conditions than to malaria directly. In children with high fever, death frequently followed convulsions. Post-malaria œdema was prevalent in the northern half of the epidemic area. It occurred chiefly in children and was regarded as a nutritional manifestation of the same nature as " war oedema " or " famine oedema ". Malaria frequently caused the interruption of pregnancy and the death rate among pregnant women who contracted the disease was high in consequence. Blackwater fever was reported on five occasions.

14. The standard treatment for adults was 7½ grains of quinine sulphate or bisulphate in solution, three times a day. It was safe even in the hands of unqualified persons and acted rapidly in reducing fever and relieving symptoms. But patients discontinued the drug as soon as they were free from symptoms and there was therefore a high relapse rate. Plasmoquine and atebrin were frequently employed for the treatment of hospital in-patients, but were considered unsuitable for use at dispensaries and in the field where close medical supervision could not be exercised.

15. Mass treatment with quinine and the supply of food where destitution and malaria co-existed were the two chief measures adopted by Government to deal with the epidemic. The latter measure was undertaken by the Government Agents of the affected provinces and their staff, under the general direction of a Commissioner for Relief. The Medical Department undertook the measures of treatment. Treatment centres were started in every group of badly affected villages, and by the third week of December there were 690 such centres in addition to the 38 permanent hospitals and 80 central dispensaries in the epidemic area. Further, 136 estates threw open their dispensaries for the treatment of village patients and were supplied with Government quinine, and other voluntary agencies also arranged treatment. Sanitary Inspectors were employed to obtain accurate information about the state of the villages so that facilities for treatment could be promptly provided wherever the rapidly changing conditions made them necessary. At the height of the epidemic there were upwards of 60,000 out-patient attendances a day at the Department's institutions in the epidemic area and during the six months, November to April, some 33,000 lb. of quinine were issued. When the epidemic began to decline, very large numbers of children were suffering from severe post-malarial debility and nutritional disorders, and arrangements were made for hospitals, dispensaries, and treatment centres to supply milk foods to them as part of their treatment.

16. The 38 Government hospitals in the epidemic area have beds for 4,000 in-patients. Accommodation for another 1,000 patients was provided by erecting temporary wards and further accommodation was arranged for malaria patients in infectious diseases hospitals and elsewhere. The congestion in the hospital wards was most acute towards the end of February when more than 6,500 in-patients were under treatment in the permanent hospitals. Twenty-two temporary hospitals with accommodation for 1,300 patients were opened by the Department during January.

February, and the beginning of March. They were usually housed in school buildings and were intended only for the treatment of malaria. Very serious cases and those complicated with dysentery or pneumonia were transferred to the nearest permanent hospital. In addition, voluntary agencies and private individuals opened 43 hospitals and convalescent homes which were visited by officers of the Department and to which the Department supplied drugs. It was necessary to lay down certain standards and conditions for temporary hospitals.

17. Extensive anti-larval measures were started in January. The oiling of breeding places in the beds of the main rivers and their larger tributaries was undertaken where *A. culicifacies* larvae were found to be prevalent. A mobile organization for this work was rapidly built up and some 300 miles of the four main rivers and their tributaries were brought under control. In many village areas an attempt was made to get rid of subsidiary breeding places. In and around Colombo intensive anti-larval measures were taken against *A. culicifacies* in order to protect the city from malaria. As there were no legal powers for carrying out these anti-mosquito measures, emergency regulations were drafted and issued in February as " The Malaria (Epidemic) Regulations, 1935 ".

18. There are frequent reference in the literature of Ceylon to unusual prevalence, outbreaks and epidemics of malaria, and no province escapes mention, but until the beginning of the present century there is no record sufficiently detailed to give a clear picture of an epidemic. Since 1900, excessive mortality in any year appears always to have been due to malaria except in 1919, the year of the influenza epidemic. The years 1906, 1911, 1914, 1923, 1928, and 1930 were years of epidemic malaria which seriously increased the annual death rates. The 1906 epidemic started in April and affected much the same area as the present epidemic. The 1911 epidemic occurred after the break of the south-west monsoon following a prolonged drought and was confined to the Western, Sabaragamuwa, and Central Provinces. The epidemic of 1914 reached its peak in January and the Eastern and Uva Provinces were chiefly involved. The 1923 epidemic affected the Eastern and North-Central Provinces early in the year and also the Kegalla District where there had been a widespread epidemic from May to August of the previous year. The epidemic of 1928 was attributed to heavy rain following a long drought and affected first the North-Western and Sabaragamuwa Provinces and also Uva, then in July the Central Province and at the end of the year the North-Central Province and parts of the Southern Province. The Northern, North-Central, Eastern and part of the Southern Provinces suffered heavily from malaria at the end of 1929 and beginning of 1930.

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Colombo, August 21, 1935.

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APPENDICES.

APPENDIX 1.

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APPENDIX 2.

Memorandum on Areas likely to suffer from Malaria during and after Heavy Rainfall in late 1934.

The areas which suffered most from the drought proper, apparently, are those areas which receive their normal precipitation during the south-west monsoon, which this year failed to reach a satisfactory amount. The average rainfall for this area in 1934 though being higher than the previous year—up to the end of September was not uniformly distributed through the usual months of the monsoon.

In regard to the dry zone, the general rainfall is during the north-east monsoon—October to March—but a certain amount is generally expected during the period May-July but not sufficient to be called a monsoon.

The south-western quadrant of the Island, normally subjected to heavy precipitation, suffered more or less intense drought conditions for a period of 4 to 5 months. The principal effects produced by such arid conditions concerned generally the hydrographic features—*e.g.*, rivers, wells, reservoirs, sub-surface water-levels.

During such conditions of reduced water-table levels it is probable that rivers have so dried up that only a series of small sandy pools have been the sole remains of water in the river-bed; fresh pits may have been dug near rivers by villagers for the purposes of obtaining water-supplies; reservoirs may have been depleted, *e.g.*, at Puttalam. that the entire village may have removed to a riverside for temporary residence; the general water-table being reduced hardship would have resulted through a dearth of water; all these conditions are not unfavourable to the commencement, transmission, and maintenance of malaria.

The essential feature of all these conditions would be the provision of suitable breeding-grounds of *A. culicifacies.* The combination of breeding-grounds and reduced vitality favours the start of malaria in a community not enjoying as a rule the benefits of immunity conferred by previous and repeated attacks. The south-west quadrant is not very malarious—except in some regions along the foot-hills—and consequently epidemics may occur if the pre-epidemic conditions of the Infection Quantum and Immunity Quantum are at a low ebb. Stated otherwise, it is assumed that infections have been long interrupted—owing to unfavourable transmission circumstances—and further that the immunity quantum is low owing to the absence of infection over a relatively prolonged period. In such areas epidemic explosions are likely to occur when conditions become suddenly favourable to transmission. Therefore, there are areas which might receive attention by the authorities and at the same time, it must be pointed out that in the absence of certain essential knowledge, *e.g.*, infection quantum, anopheline quantum, &c., only a probable forecast is possible. A list of areas is given below for the south-west quadrant, *i.e.*, the Western, Sabaragamuwa, Southern, and the lower half of North-Western Province. Added to this list are certain areas of the Central Province.

It is not proposed to discuss here in detail the influence of rainfall during, before and after the south-west monsoon in the Kelani Valley area, but it is interesting to note the relation of rainfall to the increased prevalence of malaria. In 1928 the rainfall in April and during the south-west monsoon was deficient, but was heavy in October, and at the start of the north-east monsoon. In 1929 the rainfall in April and the beginning of the monsoon was moderate in amount, but was followed by relatively low rainfall in October and the north-east monsoon. In 1930 and 1931 the April rains were deficient and the south-west rains (May and June) heavy or moderate. the October rains in 1930 were also heavy whereas in 1931 they were deficient, and in both years the November and December rains (north-east monsoon) were slight. The rainfall in all the above periods was heavy or moderate in amount in 1932.

In both 1931 and 1932 the years during the period covered in which the malaria was greatest—the increased incidence occurred mainly in the pre-south-west monsoon season, *i.e.*, from February to April or May following deficient rainfall in the north-east monsoon. In 1933 there were minor floods along the valley and it was not followed by any increase in malaria though such increase had been generally reported during the floods (? malaria) by the Government Agent, Western Province. The full discussion of this phase of study would take up a great deal of time and therefore I would submit the following areas within the Kelani river basin as worthy of observation:—

Western Province.—Siyane korale east and west, Hewagam korale, Gangaboda pattu.

Villages along the Kelani River: North Bank.—Pattiwela, Bollegalla, Malwana, Guruwala, Tittipattara, Kapugoda, Giridara, Dompe, Ganegoda, Dekatana, Palugama, Samanbadda, Owitigama, Polpita, Pugoda, Indolemulla. Villages within two miles of the north bank should be observed carefully.

South Bank.—Kanampella, Kosgama, Eswatte, Puwakpitiya, Kahahena, Mabola Welikana, Mawatagama, Hanwella, Nelunattuduwa, Palpola, Bomiriya, Kohilawatta, Mulleriyawa, Angoda, Kadabuthgamuwa. Villages within 1½ miles of the south bank should be under observation.

Large Villages in Western Province.—Watupitiwala, Radawana, Padukka.

The following dispensaries may be asked to report any increased incidence in malaria among the villages they serve:—Kadawata, Kelaniya, Bollegalla, Padukka, Wellampitiya, Kaduwela, Pugoda, Dompe, Mulleriyawa, Hanwella, Waga, Kosgama, Pannipitiya, Homagama, Avissawella, Radawana, Watupitiwala. The reports should include, all cases treated, number of malaria cases treated, and preferably confined to first visits only—if this is practicable.

Negombo District.—Villages along the Maha-oya.

Kalutara District.—Anguruwatota, Neboda, Kallewellawa. Recently opened up lands. Colonization schemes.

Southern Province.—Tangalla and Matara Districts. Madampe (Ambalangoda).

Sabaragamuwa.—Ratnapura and environs; Kegalla and surrounding area; Karawanella and villages; Balangoda area, Opanake and surrounding villages.

Central Province.—Katugastota villages, Dumbara valley; Kengalla district; Matale District—Wahacotte, Pamunuwa, Ambanpola, Yatawatta, Kaudupelella. Villages suffering from fever have been reported around Nuwara Eliya but names have so far not been available.

North-Western Province.—Giriulla, villages along Maha-oya; Narammala.

This leaves us the Province of North-Central Province, Northern Province, Eastern Province, and Uva. These provinces are definitely in the zone of influence of the north-east monsoon and any normal seasonal recrudescence of malaria should not be regarded as an epidemic.

The entire dry zone has suffered severely from a drought. Conditions of drought are not unusual but their severity differs from year to year. Heavy rains have not yet been experienced in the dry zone. The fever season generally begins about late October and persists until the end of March. Drought and mild rains in October might precipitate an early recrudescence and for as such only could observations be made.

If I might be allowed to make a few suggestions I would mention that all those in charge of hospitals and dispensaries should be alive to the situation by recording *very* carefully any increased incidence of fever in a village or group of villages served by their institutions. To prevent loss of time and get going the machinery of prevention, the Sanitary Inspector should be informed at once of those villages and he should inspect them carefully and undertake the distribution of quinine and at the same time record the condition and supply of food stuffs available in the afflicted area. I would be very glad to receive the records of all dispensaries and hospitals reporting an increase of fever.

K. J. RUSTOMJEE,
Superintendent, Anti-Malaria Campaign.

Torrington Square,
Colombo, October 15, 1934.

APPENDIX 3.

Action to be taken in Anticipation of a Recrudescence.

Minutes of Departmental Conference of January 25, 1935.

1. *Recrudescence.*—Recrudescence, if it takes place, will begin about the end of March or early April. In the wet zone localized outbreaks of malaria, when they occur, follow deficient rainfall in January and February and are consequent on pool formation in the rivers during the hot dry weather preceding the break of the south-west monsoon.

2. *Meteorological Observations.*—The first factor to be considered is the weather. It is impossible to say at present whether or not there will be a recrudescence of the epidemic, since weather conditions cannot be predicted. The Superintendent, Anti-Malaria Campaign, is in close association with the Superintendent of the Observatory and is receiving detailed information of the nature, amount and distribution of the rainfall, on which by the third week of February it should be possible to base a pronouncement.

3. *Anopheles Culicifacies Breeding.*—The next matter to be watched is the breeding of *Anopheles culicifacies.* A watch is being kept by Entomological Assistants stationed in certain index areas in the river basins. They travel through their areas periodically and examine selected breeding places and catching stations so that any increase in the anopheline population may be noted. Their catches and reports are received and examined at the office of the Superintendent, Anti-Malaria Campaign. This is most important work and it has already been necessary to engage more Assistants temporarily in order to have them sufficiently trained to undertake the additional observations which must be made during February and the beginning of March.

4. *Anti-Mosquito Measures.*—(*a*) If an increase of culicifacies breeding is reported, additional anti-larval measures are the next step. They can, however, only be taken to prevent localized outbreaks of malaria. It is impossible to apply them throughout the whole epidemic area. There are some thousands of miles of rivers and their tributaries within this area and it would be impracticable to attempt to prevent *culicifacies* breeding everywhere. Only selected areas where there is a fairly dense population, therefore, will be placed under control. Oiling gangs have been increased and certain river areas are already being dealt with. It is important that all Urban District Councils and Sanitary Board towns in the affected area should undertake intensive measures of larval control and at a critical time like the present the work must be undertaken by Government and at Government expense.

(*b*) Where relief measures take the form of temporary employment, minor anti-larval schemes should be carried out by the labourers so employed. Medical Officers of Health have been instructed to inform Government Agents of the minor works which can usefully be done round villages and with village labour. It is, however, not to be anticipated that these works will prevent an epidemic or the recrudescence of the present epidemic, but they will help to reduce the incidence of malaria in places.

5. *Legislation for the Prevention of Malaria.*—To permit of the carrying out of some of the measures mentioned in the preceding paragraph, legislation is necessary. Regulations under the Quarantine and Prevention of Diseases Ordinance, 1897, have therefore been drafted with a view to immediate application and should remain in force until a special Ordinance is in operation. The re-drafting of the Mosquito Ordinance cannot be completed in time to allow of the measures immediately necessary being taken.

6. *Village Inspection and Observation of Out-patient Attendances.*—(*a*) The weekly visitation of villages by Sanitary Inspectors to determine existing malaria conditions will continue. Their daily reports have proved of the utmost value in providing Provincial Surgeons and Medical Officers of Health with accurate and up-to-date information on which prompt action can be taken. The increased staffs of Inspectors now employed will not be disbanded until after the danger period. The assistance of school teachers in keeping the Department informed of village conditions is now being organized.

(*b*) The hospitals and dispensaries since the start of the epidemic have submitted daily returns of the number of patients. These returns will be continued until the danger of recrudescence is past. The returns will be carefully watched for increased attendances anywhere in order that steps may be taken to provide effective treatment at the earliest possible stage. An increase in out-patient attendances is to be anticipated about a month to six weeks after the increase in the *culicifacies* population has been noted.

7. *Prophylaxis.*—The matter of prophylactic treatment has been fully discussed with Departmental officers and Colonel Clemesha, and it is not considered advisable to attempt it on a large scale during the present epidemic.

8. *Early Treatment.*—The present organization with regard to hospitals, dispensaries and treatment centres will be maintained so that facilities for immediate treatment are available everywhere should new infections start to occur. In each district treatment units will be arranged which will be moved into villages should localized recrudescence take place. Early removal of cases to hospitals will be undertaken so that thorough treatment may be given to lower the relapse rate. The temporary wards which have been constructed at the hospitals in the epidemic area and the temporary hospitals which have been arranged in this area will therefore not be abandoned until the epidemic has completely subsided.

9. *Synthetic Drugs.*—The investigations started by the Department some time ago to determine whether certain synthetic drugs can be safely used on a large scale in Ceylon for mass treatment or prevention and, if so, whether they would be in any way superior to quinine are continuing.

10. *Food Supply.*—The necessity for ensuring that the population in the affected area has sufficient food is of primary importance as anti-malarial measure and is the function of the Special Commissioner. Relief measures should not be dependent on sickness.

11. *Conclusion.*—It cannot be too strongly emphasized that the two chief measures to be taken in a malaria epidemic are the cinchonisation (quininisation) and the feeding of the population. While these measures will not stop the epidemic they lessen very considerably its intensity and reduce the death rate.

APPENDIX 4.

Note on Atebrin Mussonate for the Information of Medical Officers.

1. *Early Work with Atebrin Mussonate.*—In January and February, 1935, more than 300 persons were treated with atebrin mussonate by officers of the department working in collaboration with Dr. A. T. W. Simeons, who had received from the makers a supply of the preparation for trial. This work showed that in a large proportion of cases of malaria 0.75 grammes of atebrin mussonate is an effective therapeutic dose when given as two intramuscular injections each of 0.375 grammes with an interval of about twenty-four hours between them (Blaze and Simeons, *Ind. Med. Gaz.*, April, 1935). The two injections of 0.375 grammes have been accepted as the standard form of treatment with atebrin mussonate for adult patients. (0.375 grammes of atebrin mussonate contain 0.3 grammes of atebrin and in subsequent references to these injections the weight of the atebrin only will be given.) In this early work there was no control series of patients treated with quinine, the conditions under which the work was done did not allow the relapse rate to be determined and little significance was attached to untoward happenings since at the time atebrin was reputed to be a drug of very low toxicity.

2. *Comparison of Atebrin Mussonate and Quinine in the Treatment of 1,105 Hospital Patients.*—Further supplies of atebrin mussonate became available in Ceylon in April and during the following six weeks two parallel series of hospital in-patients suffering from malaria were treated at the same time, one series with atebrin mussonate and the other series with two intramuscular injections of quinine bihydrochloride (each of gr. xv) followed up with quinine by mouth. The intention was to have two series which were comparable as regards the type of case. Some medical officers, however, had a preference for one or other of the drugs in the treatment of certain forms of malaria and selected their patients accordingly. The records of several hospitals had therefore to be rejected as being unsuitable for correct comparison. In two hospitals the follow-up with quinine by mouth was omitted because the medical officers did not realize that the intention was to compare atebrin mussonate treatment with quinine treatment and not two injections of atebrin mussonate with two injections of quinine; two injections of quinine do not constitute a course of quinine treatment. The records from these hospitals have, however, been included in the series in order to obtain a sufficient number of cases for comparison. Tables II., III., and IV. show that the two series are strictly comparable as regards type of case.

TABLE I.

Number of Patients treated in each Hospital.

Hospital.	*Atebrin Mussonate. No. Treated.*	*Quinine. No. Treated.*
Karawanella	54	34
Kandy	83	84
Anuradhapura	39	16
Kurunegala	36	41
Watawala	37	16
Kegalla	153	102
Gampaha	15	7
Nawalapitiya	52	33
Deraniyagala	89	11
Kahawatta	45	8
Aranayaka	72	68
Dambadeniya	6	4
	681	424

TABLE II.

Analysis of Patients by Sex and Age.

	Atebrin Mussonate.		*Quinine.*	
	Number.	*Percentage.*	*Number.*	*Percentage.*
Sex—				
Males	481	71	287	68
Females	200	29	137	32
	681	100	424	100
Age—				
Under 15	116	17	101	24
15 to 35	449	66	253	60
35 and over	116	17	70	16
	681	100	424	100

TABLE III.

Clinical History and Type.

	Atebrin Mussonate.		Quinine.	
	Number.	*Percentage.*	*Number.*	*Percentage.*
History of Fever—				
Primary attack	87	13	62	15
2 weeks to 2 months	91	13	54	13
2 months to 4 months	193	28	102	24
4 months and over	306	45	206	48
Not stated	4	1	—	—
	681	100	424	100
Clinical Type—				
Simple febrile	582	86	365	86
Cerebral	30	4	29	7
Algid	7	1	2	1
Malarial cachexia	54	8	22	5
Not stated	8	1	6	1
	681	100	424	100

TABLE IV.

Results of Blood Examination.

	Atebrin Mussonate.		Quinine.	
	Number.	*Percentage.*	*Number.*	*Percentage.*
Benign tertian parasite	287	42	181	43
Malignant tertian parasite	160	23	120	28
Mixed B. T. & M. T.	50	7	25	6
Quartan parasites	4	1	4	1
No parasites found	138	21	57	13
Not stated	42	6	37	9
	681	100	424	100

(*a*) The results of treatment in the cases available for statistical analysis are shown in Table V., VI., and VII.

TABLE V.

Length of Stay in Hospital.

	Atebrin Mussonate.		Quinine.	
	Number of Patients.	*Percentage.*	*Number of Patients.*	*Percentage.*
Length of stay—				
Less than 6 days	341	50	182	43
6 days and more	340	50	242	57
	681	100	424	100
Average length of stay—				
Males	6.0 days		6.6 days	
Females	7.8 days		7.9 days	

TABLE VI.

Effect on Temperature (of Patients under Observation for Six Days or more).

	Atebrin Mussonate.		Quinine.	
	Number of Patients.	*Percentage.*	*Number of Patients.*	*Percentage.*
Stabilized	277	82	195	81
Unstabilized	58	17	46	19
Unclassified	5	1	1	—
	340	100	242	100

TABLE VII.

Time (after First Injection) taken to produce Stabilization (among Patients whose Temperature was 99°F or higher).

	Atebrin Mussonate.		Quinine.	
	Number of Patients.	*Average Time.*	*Number of Patients.*	*Average Time.*
Males	189	2 days 10 hours	127	2 days 19 hours
Females	88	2 days 17 hours	68	3 days 2 hours
	277		195	

The temperature was regarded as "stabilized" when it fell to normal and remained normal until the patient left hospital. Patients who left hospital before the end of the sixth day are excluded, since the time of observation was too short for accurate conclusions. Table VI. indicates that atebrin mussonate and quinine stabilized temperature in about the same percentage of patients, but Table VII. shows that temperature was stabilized on an average nine hours sooner among the atebrin patients. This finding would explain the shorter average length of stay in hospital of the atebrin patients (Table V.). With regard to Table V., there is mathematically no significant difference in the length of stay in hospital in the atebrin mussonate and quinine cases. The probable errors are as follows:—

	Atebrin Mussonate.	*Quinine.*	*Difference.*
Males	6.0 ± 2.52	6.6 ± 2.76	.6 ± 3.7
Females	7.8 ± 3.09	7.9 ± 3.04	.6 ± 4.3

Thus there is a large probable error both for males and females. All that can be said is that there was a tendency for the average stay in hospital to be longer for quinine cases, but this difference is not significant when the size of the sample is taken into account.

(*b*) *Effect of each Drug on Benign Tertian and Malignant Tertian Infections.*—Table VIII. shows that as regards sex and age distribution and clinical history and type, the atebrin and quinine series of cases are comparable in the benign tertian group and the malignant tertian group.

TABLE VIII.

	Benign Tertian Infections.				*Malignant Tertian Infections.*			
	Atebrin Mussonate.		*Quinine.*		*Atebrin Mussonate.*		*Quinine.*	
	No.	*Percentage.*	*No.*	*Percentage.*	*No.*	*Percentage.*	*No.*	*Percentage.*
Sex—								
Males	212	74	123	68	103	64	77	64
Females	75	26	58	32	57	36	43	36
	287	100	181	100	160	100	120	100
Age—								
Under 15	55	19	38	21	28	18	27	22
15 to 35	179	62	114	63	106	66	73	61
35 and over	53	19	29	16	26	16	20	17
	287	100	181	100	160	100	120	100
History of Fever—								
Primary attack	29	10	22	12	22	14	18	15
2 weeks to 2 months	42	15	22	12	27	17	15	12
2 months to 4 months	72	25	48	27	50	31	31	26
4 months and over	141	49	86	47	61	38	55	46
Not stated	3	1	3	2	—	—	1	1
	287	100	181	100	160	100	120	100
Clinical Type—								
Simple febrile	253	88	161	89	132	83	101	84
Cerebral	8	3	3	2	13	8	10	8
Algid	—	—	—	—	2	1	—	—
Malarial cachexia	16	6	4	2	10	6	6	5
Not stated	10	3	13	7	3	2	3	3
	287	100	181	100	160	100	120	100

Tables IX. and X. show the results obtained :—

TABLE IX.

Length of Stay in Hospital.

	Benign Tertian.				*Malignant Tertian.*			
	Atebrin Mussonate.		*Quinine.*		*Atebrin Mussonate.*		*Quinine.*	
	No. of Patients.	*Percentage.*	*No. of Patients.*	*Percentage.*	*No. of Patients.*	*Percentage.*	*No. o Patients.*	*Percentage.*
Length of Stay—								
Less than 6 days	133	46	71	39	79	49	52	43
6 days and more	154	54	110	61	81	51	68	57
	287	100	181	100	160	100	120	100
Average Stay—								
Males	6 days 17 hours		6 days 22 hours		6 days 2 hours		7 days	
Females	9 days		8 days 10 hours		8 days 2 hours		7 days 10 hours	

TABLE X.

Time (after first injection) taken to produce stabilization of temperature (among patients whose temperature was 99° F or higher).

	Benign Tertian.				*Malignant Tertian.*			
	Atebrin Mussonate.		*Quinine.*		*Atebrin Mussonate.*		*Quinine.*	
	No. of Patients.	*Average Time.*	*No. of Patients.*	*Average Time.*	*No. of Patients.*	*Average Time.*	*No. of Patients.*	*Average Time.*
Males	64	2 days 12 hours	61	3 days 2 hours	32	3 days 5 hours	33	3 days 10 hours
Females	30	2 days 7 hours	27	3 days 7 hours	28	3 days 19 hours	17	3 days 5 hours
	94		88		60		50	

Table X. indicates that in the benign tertian group temperature was stabilized in males 14 hours and in females 24 hours sooner by atebrin than by quinine; in the malignant tertian group the difference in favour of atebrin among males was only 5 hours and among females quinine acted 14 hours sooner than atebrin. But the numbers are too small to allow of definite conclusions being drawn from the results of the groups studied.

(c) *Pain and Abscess at Site of Injection.*—Of the 681 atebrin-treated patients, 145 or 21.3 per cent. developed pain at the site of injection and 2 developed an abscess. Of the 424 quinine-treated patients 155 or 36.5 per cent. developed pain at the site of injection; abscess formation did not occur.

(d) *Toxic Effects.*—

TABLE XI.

	Atebrin Mussonate.		*Quinine.*	
	No. of times the condition was noted in 681 patients.	*Percentage.*	*No. of times the condition was noted in 424 patients.*	*Percentage.*
Discoloured skin or sclerotics	35	5.1	—	—
Gastro-intestinal signs—				
(*a*) vomiting	15	3.4	—	—
(*b*) abdominal pain	8		1	0.2
Mental derangement	13	1.9	1	0.2
Giddiness	8	1.2	—	—
Collapse	2	0.3	—	—
Death	4	0.6	—	—

The significance of the toxic effects will be discussed later. With regard to the mental manifestations, most Medical Officers are now familiar with the mental derangement caused by atebrin and there is no need to describe the 13 cases in detail. In five patients it followed the first injection and in 8 it occurred between 1½ and 30 hours after the second injection. Two of the 13 cases were mild in type and in only one did symptoms continue for more than 5 days. The case of mental disturbance in the quinine series was probably due to the malaria and serves to emphasize the fact that every case of mental disorder after atebrin was not necessarily attributable to the drug.

(e) *Deaths.*—Among 681 patients treated with atebrin mussonate 17 or 2.5 per cent. died and among 424 treated with quinine 6 or 1.4 per cent. died. Four of the 17 deaths following atebrin mussonate were attributed to the toxic effect of the drug. If these four cases are excluded, the natural death rate among the atebrin-treated cases would have been 1.9 per cent., which is not significantly greater than the death rate for the quinine-treated series.

The causes of death were—

	Atebrin Mussonate Cases.	*Quinine Cases.*
Pneumonia ..	7	1
Pulmonary oedema	1	—
Cerebral malaria	1	2
Dysentery or diarrhoea	2	2
Convulsions	1	—
Heart failure	1	—
Haemoglobinuria	—	1
Attributed to the drug	4	—
	17	6

The following is a brief account of each of the four deaths attributed to atebrin mussonate :—

S. f. age 20. Admitted May 3. Malaria on and off for 12 weeks. Thirty-two weeks pregnant. Temperature 98.4° on admission, 100° the next day; spleen enlarged " 3 finger breadths ", anaemic. Six hours after first injection of 0.3 grammes atebrin she collapsed and died 10 hours later of heart failure.

M. m. age 4. Admitted April 27. Malaria on and off for 24 weeks. Spleen enlarged " 4 finger breadths ", liver enlarged, Hb. 75 per cent. B. T. infection. Temperature 98.4 on admission. Child not very ill and sitting up in bed playing just before the injection. He collapsed and died 4 minutes after the first injection of 0.08 grammes atebrin. Post-mortem—enlarged spleen and liver but nothing found to account for death.

S. m. 8 months. Admitted April 25. Temperature 99°, pulse 120, respiration 32. Lungs clear, spleen and liver not enlarged. B.T. infection. April 26 given injection of 0.05 grammes atebrin. Immediately afterwards patient vomited bile stained fluid and six hours later became cold and clammy with dilated pupils and feeble pulse. Death took place 16 hours after the injection.

R. f. age 2. Admitted May 5. Temperature 103°, pulse 128. M.T. infection. May 7, given 0.06 grammes atebrin. May 8, temperature 101° and a second injection of 0.06 grammes given. Immediate collapse, and death a minute or two later. Post-mortem—spleen enlarged, lungs clear, nothing found to account for death.

3. *Relapses.*—It was not possible to determine the number of relapses after treatment in the series of 1,105 hospital patients, since the length of stay in hospital was too short. The following four small series of patients (not included in the above) treated with atebrin mussonate are therefore given :—

(i.) Seventy-nine patients were treated by Dr. P. B. Fernando at the General Hospital, Colombo. Each patient received two injections of atebrin and, with 9 exceptions, were kept for a minimum period of three weeks in hospital where the risk of reinfection was considered negligible. There were 70 males and 9 females. Six were under 15 years of age, 51 were aged 15 to 35 and 22 were 35 and over. Thirty were suffering from a primary attack, 13 had had malaria for two weeks to two months, 18 for two months to four months, and 18 for four months or longer. The clinical types were 75 simple febrile, 2 cerebral, 1 algid, and 1 malarial cachexia. In 31 the infection was benign tertian, in 27 malignant tertian, in 19 mixed B.T. and M.T. and in two no parasites were found. Four of the patients died and 5 others were excluded on account of complications or severe toxic symptoms. Among the 70 remaining patients 20 had " relapses " as shown in the following table (Dr. Fernando only included patients who had both a return of fever and of parasites in the blood, among his cases of relapse.) :—

TABLE XII.

No. of days after temperature became normal.	*First Relapse.*	*Second Relapse.*
4 to 9	7	4
10 to 15	6	1
16 to 21	7	—
	20	5

In these 20 patients the average afebrile period before relapse was 11.8 days.

(ii.) Dr. C. G. Hoole treated 20 policemen with injections of atebrin mussonate. These men had been sent from outstations where they had contracted malaria, to the Police Hospital, Colombo, for treatment. After treatment they remained in Colombo where there was little risk of reinfection. In 2 patients the first injection was followed by toxic symptoms and a second injection was not given. Of the remaining 18 patients, 10 relapsed within a month, viz., 3 within the first fortnight and 7 during the fourth week.

(iii.) Dr. S. de Silva reported that at the Mahara Jail, of 18 policemen suffering from malaria whom he had treated with atebrin mussonate (two injections each) 1 relapsed in the second week, 2 in the third, 3 in the fourth, and 2 in the fifth. The risk of reinfection existed but was not great during this period.

(iv.) The best results so far obtained were among 65 members of the Kurunegala Hospital staff treated in February in collaboration with Dr. Simeons. During the six weeks following treatment 7 of them developed fever and the possibility of reinfection cannot be excluded in this series.

It will be noted that Dr. P. B. Fernando's series consisted of hospital patients who were obviously very ill; there were four deaths and a very high percentage of mixed infections among them. The Kurunegala series consisted not of hospital patients but of hospital staff who although they had all had malaria were mostly still on duty and not acutely ill at the time of treatment. There is no comparable series of quinine-treated patients in which the number of relapses can be given.

4. *Field Treatment with Atebrin Mussonate of 1,387 Patients.*—Between May 20 and 31, 1,387 persons in three groups of malarious villages received injections of atebrin mussonate. The intention was to determine the effect of the treatment on the health of each group of villages by treating as great a proportion of the inhabitants as possible, but safe treatment rather than mass treatment was aimed at. In the series of 1,105 hospital cases, the patients were unselected; in the village treatments, very careful selection of patients was made. Each person presenting himself for treatment was subjected to a medical examination of about six minutes' duration. Those suffering from any condition likely to interfere with the renal function, *e.g.*, nephritis, advanced hookworm disease, oedema, and the toxaemias of pregnancy were excluded, as also were cases of advanced debility and anaemia. This medical examination eliminated a considerable proportion of the persons presenting themselves, and the patients so rejected were not given atebrin but were treated with other drugs. Particular caution was exercised in treating babies and small children with atebrin injections. A further measure of safety to keep down the accident rate had been suggested by Dr. Simeons, and was adopted. A meal consisting of a bowl of soup and rice conjee was given to each adult patient before the atebrin injection, and sugar or sugar candy was given to the children.

(*a*) The village groups were as follows :—

Group I. Aranayake villages. Population 3,373.
(Dr. N. Kelaart, Dr. B. Joseph, and Dr. R. V. N. Rudolph.)

Group II. Narammala villages. Population 4,237.
(Dr. D. B. d'Alwis, Dr. L. Udalagama, and Dr. W. J. Silva.)

Group III. Kosgama villages. Population 6,304.
(Dr. L. G. Blaze, Dr. R. G. Perera, Dr. F. C. Ebert, and Dr. S. G. Abeyasinghe.)

TABLE XIII.

No. of persons who —	*Group I. Aranayake Villages.*	*Group II. Narammala Villages.*	*Group III. Kosgama Villages.*
Presented themselves for treatment	695	unrecorded	235
Received first atebrin injection	541	644	202
Received second atebrin injection	515	556	186
Were " followed-up " 3 weeks after treatment	unrecorded	457	150
Developed fever within three weeks of treatment	66	164	67

Owing to the small proportion of the population treated—16.0 per cent. in Group I., 13.1 per cent. in Group II., and 3.2 per cent. in Group III.—the effect on the general health of the villages was not appreciable.

(*b*) It is impossible to determine the relapse rate after treatment in these areas because a considerable liability to reinfection existed, but allowing for the incubation period, return of fever within 10 or 14 days may be considered as due to the original infection. Dr. Kelaart states that in Group I. " 7.5 per cent. of cases treated had fever within a fortnight of treatment ". Dr. Udalagama found that of the 457 patients followed up in Group II., 31 or 6.8 per cent. had fever within 10 days of treatment, and Dr. Ebert found that of the 150 patients whom he followed up in Group III., 10 or 6.7 per cent. had fever within two weeks. Dr. Ebert made blood films from 117 of the 150 patients whom he followed up, irrespective of whether they had fever or not at the time (*i.e.*, three weeks after the completion of treatment). Forty-nine films were positive, viz., B.T. 36, M.T. 13.

(*c*) Toxic manifestations and accidents were comparatively few, thanks to the precautions taken. Dr. Kelaart reported discolouration of the skin in one case, persistent vomiting (which he defined as vomiting coming on very soon after the injection and lasting four or more hours) 30 cases; abdominal pain 6; mental derangement 1, bad case (the patient had to be kept in hospital for five days and restrained by means of a strait jacket); collapse after the injection, 8 cases; and abscess formation at the site of injection, 2 cases. There were also a number of patients who developed painful swelling and induration at the site of injection, which lasted more than a week and the majority of patients complained of pain for two to four days.

In Group II., 7 patients became mentally deranged after treatment. In 6 cases, the onset of symptoms occurred within a few hours of the second injection and in one case within 2½ hours of the first injection. In five of the patients the mental derangement persisted more than a week and one of these patients died of exhaustion. Twenty-three patients had other toxic symptoms soon after the injections, such as faintness and collapse, nausea, and vomiting and 7 developed an abscess at the site of injection.

In Group III., some patients suffered from giddiness or nausea after the injections, but none developed mental symptoms and abscess formation did not occur, though 16 of the 150 patients followed up still complained of pain three weeks after treatment.

(*d*) The poor response on the part of the villagers was attributed by Dr. Blaze to fear of mental symptoms, since atebrin by mouth had been given to several hundred persons in the area during the previous few months and there had been at least 15 cases of mental derangement and the oral administration of atebrin at the Kosgama Dispensary was abandoned for this reason. Dr. Kelaart considered the pain after injection and the disability caused thereby made the injections unpopular and Dr. d'Alwis attributed the unpopularity to the various toxic manifestations—mental, alimentary, and cardiac—following treatment.

(*e*) The cost of the atebrin mussonate, staff, feeding of patients, and incidental expenses averaged Rs. 4.24 per head for the 1,387 persons treated.

5. *Field Treatments with Quinine.*—Between June 3 and July 28 Dr. W. J. Silva treated 3,853 persons with quinine in certain badly affected villages in the Minuwangoda and Gampaha areas. In 2,321 of them he started treatment with an intramuscular injection of quinine and followed it up with quinine by mouth for a week. Abscess formation did not occur, but among 554 whom he saw towards the end of July, 16 still complained of pain and tenderness. He recorded that 18 of the patients had had relapses.

Dr. S. G. Abeyasinghe treated with quinine 1,104 persons in villages of the Kotadeniyawa area during three weeks in June and July. In 517 the treatment was started with an intramuscular injection and followed up with 20 grains a day by mouth. Abscess did not result in any case, but 43 of the 1,104 patients returned with fever within a fortnight.

6. *Discussion of Toxic Effects: (a) Sudden Deaths after Atebrin Injections.*—Death may supervene a few minutes or a few hours after an intramuscular injection of atebrin and is preceded either by collapse or by convulsions. Collapse is the more frequent condition. The slight faintness or giddiness which sometimes follows an injection is probably an early sign of collapse which goes no further; the collapse may be severe and energetic treatment may be necessary to bring about recovery, or it may terminate in death. It has occurred most frequently in children. The following example is typical:—

> Y. f. 2 years. Admitted Balangoda Hospital, July 20. History of fever, chills and rigors for four weeks. Temperature on admission 102.8, spleen enlarged " two finger breadths ". Evening temperature 100.8. July 21, morning temperature 97, afternoon temperature 101. Atebrin injection 0.1 gramme, 4 P.M. Collapse immediately after the injection; death within four minutes.

Among adults, pregnant women have been found particularly liable to collapse after the injections. Convulsions due to malaria were of frequent occurrence among children in the early stages of the epidemic. Convulsions occurring a few minutes or hours after an atebrin injection and attributed by the medical officer concerned to the atebrin injection, have occurred in both children and adults. They are not always fatal. Thus, a boy aged 10 at the General Hospital, Colombo, developed epileptiform convulsions 15 minutes after an atebrin injection but recovered. The first fatal case was a child three years of age treated at Madawa in February. It had a severe convulsion within ten minutes of receiving the first injection and died soon afterwards. Messrs. Bayer's Scientific Representative in India who was present has suggested the possibility of air embolism as the cause of death. But air embolism is very rare after an intramuscular injection and other similar cases have occurred after atebrin but not after quinine injections, and pulmonary rather than cerebral manifestatios would have been expected. These cases of death from convulsions have been rare and probably did not occur oftener than once in every 900 or 1,000 treatments.

(*b*) *Chronic Poisoning by Atebrin.*—This condition has been referred to as delayed atebrin poisoning and may occur after atebrin administered by mouth or by injection. It appears to depend on some disturbance of the kidney function. Atebrin is normally excreted from the body in the urine. Manson Bahr (Practitioner No. 782, 1933) states that " Atebrin is excreted in the urine which becomes highly coloured and also in the perspiration ". In Ceylon it has been found that traces of atebrin usually appeared in the urine from a half to one hour after an intramuscular injection or 15 to 24 hours after the start of a course of treatment by mouth. The staining of the skin may be an attempt on the part of the body to excrete the drug by this route when normal excretion by the kidneys is not taking place. In most cases of atebrin poisoning when symptoms arise some days or weeks after the atebrin has been taken, staining of the skin is present. Peters (Trans. R. S. T. M. & H. Vol. XXIX. No. 1 p. 46) in speaking of atebrin states that " excretion takes place through the urine and faeces ". In certain Ceylon hospitals it was noticed that occasionally the stools of patients taking atebrin by mouth were discoloured by the drug. This was especially noticeable with babies and small children whose napkins were often stained yellow by the faeces as well as the urine; but when atebrin was given by injection, only the urine produced staining. Probably what happened was that part of the atebrin administered orally was not absorbed and passed out of the bowel unchanged. Thus, the view has been formed that normally atebrin is excreted only by the kidneys and that if the kidneys fail to excrete the drug signs of poisoning may supervene.

Dr. P. B. Fernando describes the following case which supports this view:—

> P. m. Admitted June 7, 1935, with B.T. malaria temperature 102°. He was given two injections of atebrin mussonate (0.3 grammes) on June 8 and 9. On 10th evening he complained of severe headache and on 11th morning he was found in a collapsed condition. He was cold and clammy, dazed and could not speak. B.P. 100/65. Pulse 90. Reflexes normal. Lumbar puncture was done and fluid was found clear and under slight tention. No atebrin was found in the C.S.F. or urine. On 12th there was still no atebrin in the urine. On 13th he vomited twice and again passed into a collapsed condition. On the 14th atebrin appeared in the urine and he started to improve.

Dr. P. B. Fernando also states that 3.3 per cent. of the patients treated with atebrin by mouth developed yellow pigmentation or toxic symptoms such as severe pain in the epigastrium, and although most of these patients quickly recovered from the symptoms, two patients had severe collapse and a third collapsed and died. One of the former was excreting albumen and the last was found post-mortem to have granular kidneys.

The following report by Professor E. K. Wolff on a case of suspected atebrin poisoning lends support to Dr. Fernando's view :—

> Patient, m. 32 years, B.H.T. No. 2395, admitted on January 23, 1935, with fever and chills. No rigors. Had oedema of limbs, jaundice and dyspnoea at time of admission. History of illness of several months. Heart enlarged, haemic murmur. Liver and spleen enlarged. Scanty malignant tertian rings found once in blood films. On three other occasions negative.
>
> Treatment. atebrin one tablet, t. d. s. from time of admission (*i.e.*, 6 tablets taken). Quinine bihydrochloride grains 20 injected intramuscularly at 9 P.M. on January 25.
>
> Died on January 26.
>
> Autopsy Findings. P.M. No. 36 of 1935. There was a general yellow colouration of the body. Meninges yellow. external hydrocephalous present. Brain yellow. had a pungent aromatic odour. Yellow greenish fluid with the same smell was found in all serous cavities. Liver too had the same colour, and spleen was enlarged. No parasites found in post-mortem smears. Urine post-mortem had a dark colour without any greenish pigmentation. Chemical examination for atebrin was negative.

Histology. Changes were most marked in the kidneys. There were old glomerular changes with superimposed recent acute ones. There was lobulation and swelling of the glomeruli; some glomeruli showed fresh necrosis of the capillary tufts followed by exudation and baemorrhage.

In the following case also in which a baby probably received an overdose of atebrin, death seems to have been due to failure to excrete the drug. A mother who was given three atebrin tablets for a child of ten gave some or all of them to a baby two months old. Four days later the baby was brought to hospital in a semi-comatose condition with the skin stained a deep yellow and death took place shortly afterwards.

The following detailed notes on another case are of much interest, in view of the period of time which elapsed between the administration of the atebrin injections and death :—

A. M. m. 20 years. Admitted under Dr. P. B. Fernando's care at the General Hospital, Colombo, on July 14, 1935.

Complaint.—Fever with rigors of three days' duration. Vomiting of two days' duration.

History.—Patient has had atebrin mussonate injections of 0.3 grammes at the Kurunegala hospital, one on May 14 and one on May 15. Since then he has had no fever till three days ago when he again had fever with rigors and vomiting.

Examination.—Patient was "jaundiced", the sclerotics stained yellow, &c. He was looking very ill and asthenic, spoke coherently and intelligently, but with great difficulty. He had a queer expression on his face and was staring into space.

Cardio-vascular System.—Heart within normal limits; sounds rapid. No adventitious sounds. Pulse 130 regular. B.P. 120/50.

Respiratory System.—Lungs clear. No adventitious sounds. Resp. 20 per minute.

Abdomen.—Soft. Moves with reop. Liver not palpable, tenderness over inf. border of liver, no rigidity. Spleen +^{d} 3^{f}.

Blood.—(*a*) M.P. nil. (*b*)
(*b*) Van den Bergh :—Direct +^{ve} (immediate)
Indirect +^{ve}

Urine.—Albumen nil
Sugar nil
Bile nil } 15.7.35.
Atebrin nil
Atebrin nil
Deposits :—few uric acid } 16.7.35.
crystals +

Treatment and Progress.—On admission patient was given digitalis and quinine in addition to large quantities of glucose and sodi bicarb solution by mouth. Next day he was looking much worse, was drowsy, complained of headache and had hiccough. Pulse was 126 p.m. Digitalin injections were given in addition to other medicines.

He died on the night of the 16th instant. As atebrin poisoning was suspected a post-mortem examination was insisted upon.

Post-mortem Report No. 243 (by Dr. Austin): July 17, 1935.—A striking feature was a bright canary yellow colouring of the tissues, quite unlike that met with in jaundice. The brain weighed 2¼ lb., it was not congested but was rather yellow. The cerebro-spinal fluid was yellow, the ependyma and choroid plexuses were coloured yellow too. The root of the tongue, wall of the pharynx, oesophagus, &c., were coloured yellow. The mucosa of the trachea and bronchi was yellow and even the sputum in the bronchi was stained. There were three ounces of dark brown fluid in the pleural cavities in each side. The lungs were oedematous and yellowish grey in colour. The pericardial cavity contained a bright yellow fluid. The heart—the epicardial fat was a brilliant yellow, the myocardium valves, &c., were normal. There was no fluid in the peritoneal cavity. The liver was enlarged and congested. The gall bladder was full of thick blackish bile. The spleen was enlarged and dark in colour. The kidneys were yellow in colour, but otherwise microscopically they appeared normal. The bladder was distended.

Report by Dr. E. M. Wijerama on post-mortem material collected from P.M. No. 243 of July 17, 1935.

1. Pleural fluid was clear. Had a yellow colour and was chemically *positive for atebrin.*
2. Pericardial fluid too was clear. Was lighter in colour than pleural fluid. Gave *a positive* chemical test for atebrin.
3. Urine was of amber colour and was *negative for atebrin.*
4. Spleen smear and brain squash were examined by Dr. de Saram. No parasites were found in either film. Malarial pigment was present in the spleen smear.

Test adopted for identification of atebrin was the extraction of the pigment with amyl alcohol from an alkalinized fluid. A positive extract gives a green fluorescence against a black background. Alkalinization is done to prevent extraction of other pigments like urobilin which can be extracted only from acid solution.

Histological Report by Professor E. K. Wolff. Brain.—No malarial pigment : no pathological findings.

Kidneys.—Reaction of Bowman's capsule in the form of proliferation forming many epithelial layers. The glomeruli are not very markedly lobulated. There is marked fatty infiltration of the tubular epithelium. No malarial pigment.

Spleen shows large amount of malarial pigment within reticulum cells, scattered irregularly over the organ; the secondary follicles of the Malpighian bodies show fatty degeneration; the white pulp is enlarged and contains a large amount of blood; there are small areas of haemopoietic tissue within the white pulp.

Liver shows accumulation of large masses of malarial pigment within the interlobular tissue; only a few Kuppfer cells are carrying pigment. There is marked chronic inflammation of the interlobular tissue and cell proliferation within the capillaries originating from Kuppfer cells. There is congestion and intracapillary leucocytosis.

7. *Conclusions.*—In arriving at conclusions about the merits and defects of the drugs used it is essential to remember that a severe epidemic of malaria was in progress, that the majority of patients were villagers who had been infected and reinfected with malaria on several or many occasions and that normally these villagers do not possess very robust health, since hookworm infestation is prevalent among them and their everyday diet is poor; but from the series of cases studied and from other experience gained during the epidemic it is possible to express certain opinions.

(*a*) Atebrin mussonate and quinine have been effective in reducing fever and controlling symptoms in about the same proportion of patients suffering from malaria. The order of rapidity with which these results were brought about has appeared to be as follows :—

(1) Atebrin mussonate two intramuscular injections.
(2) Quinine bihydrochloride two intramuscular injections.
(3) Quinine by mouth.
(4) Atebrin by mouth.

It was impossible to say beforehand in any particular case or small group of cases whether atebrin injections or quinine injections would produce the more rapid results.

(*b*) The data available have not allowed definite conclusions to be drawn about the relapse rate and no strict definition of "relapse" or "relapse rate" has therefore been followed. There was, however, sufficient evidence to show that in a fairly large proportion of patients the disease is not cured by atebrin mussonate, the failure to cure being indicated either by the reappearance of parasites in the blood or by subsequent attacks of fever. Whether this proportion was greater or less than it would have been after quinine treatment or treatment with atebrin by mouth was not determined with accuracy, but the impression exists that a full course of atebrin by mouth (1.5 grammes) has a greater effect in preventing the return of fever than a week's careful treatment with quinine and that either of these courses of treatment is superior in this respect to the two injections of atebrin mussonate.

(*c*) Pain at the site of injection occurred after atebrin but not so frequently as after quinine. The pain after an atebrin injection may be severe and swelling and induration and even abscess formation occurred and required careful treatment. The atebrin abscess was as slow and indolent in healing as a quinine abscess and had the same tendency to track along the fasciae and cause extensive damage to the tissues.

(*d*) Minor toxic manifestations such as vomiting and abdominal pain occurred in a small percentage of patients after atebrin injections but these symptoms were easily controllable and did not occur so frequently as after atebrin by mouth.

(*e*) The temporary mental derangement which may result from the administration of atebrin is a very serious objection to the use of this drug. The condition follows intramuscular injections almost as frequently as courses of atebrin by mouth, in spite of the smaller dose in the former method of treatment. Cases of mental derangement due directly to malaria were met with during the epidemic and have been described by medical officers but have been by no means so common as the cases following atebrin treatment.

(*f*) *Accident Rate.*—Under the term accident rate may be included the bad cases of collapse and convulsions whether they ended in recovery or death. Probably in rather more than a ½ per cent. of the hospital patients treated with atebrin mussonate death has been attributed to the drug. The greatest care is necessary in the selection of patients for treatment.

(*g*) *Contra Indications.*—The manufacturers' statement about atebrin for injection—" Contra indications: None "—has not been borne out by experience in Ceylon. Atebrin whether administered by mouth or injection is definitely contra-indicated whenever there is any disturbance of the kidney function. All the cases of chronic poisoning which have been under notice appear to have been associated with imperfect excretion of the drug in the urine. It should, therefore, never be given to patients suffering from nephritis, advanced hookworm disease or any of the toxaemias of pregnancy. Small children have been specially liable to develop sudden collapse or convulsions after the injection and the dose recommended for them by the manufacturers, viz., " Up to 4 years . . . 0.1 g. per day, 5-8 years . . . 0.2 g. per day " is dangerously high. It must be given with great caution to debilitated and anaemic persons, and if serious accidents are to be avoided a careful medical examination of the patient including analysis of the urine should be made before the injections are given. Further, during and after treatment the patient should be carefully watched to see that excretion of the drug is taking place.

(*h*) Medical Officers may ask " when should atebrin injections be used? ". The majority of patients suffering from malaria do not require to be treated with injections, whether of quinine or atebrin. When, however, treatment by injection is indicated, quinine is to be preferred to atebrin on account of its greater safety; but there will be exceptional cases in which an experienced Medical Officer will exercise his discretion in favour of atebrin.

APPENDIX 5.

Office of the Director of Medical and Sanitary Services,
Colombo, December 8, 1934.

Instructions to Officers.

In any area in which a severe epidemic of malaria occurs the Provincial Surgeon should mobilize all the medical resources available, whether of the medical or sanitary side of the Department or of the Anti-Malaria Campaign, to deal with the situation. Such additional staff as the Provincial Surgeon considers necessary may be engaged, branch dispensaries and visiting stations may be temporarily converted into central dispensaries and treatment centres opened. The covering approval of the Head Office should be sought as soon as possible after action has been taken.

2. In certain areas the need for free distribution of food exists. When the Medical Officer or Apothecary considers such distribution necessary in his area he should at once write to the Provincial Surgeon setting out his views and should send a copy of the letter direct to the Government Agent or Assistant Government Agent for information and necessary action. Should the Government Agent or his representative wish to use a part of the dispensary premises for the distribution of food, every facility should be given, provided it does not interfere with the work of the dispensary. The staff of the Department, however, has its own duties to perform and cannot undertake food distribution.

3. During the period of the epidemic daily returns should be forwarded every night to this office and to the Provincial Surgeon as follows :—

Dispensary .... Date ....
Number of attendances for malaria ....
Number of attendances for other diseases ....

R. BRIERCLIFFE,
Director of Medical and Sanitary Services.

C. E. TILNEY,
Administrative Secretary.

APPENDIX 6.

Office of the Director of Medical and Sanitary Services,
Colombo, December 18, 1934.

Duties of Sanitary Inspectors in Areas where Malaria is Epidemic.

During the present epidemic of malaria, Sanitary Inspectors are to be employed as far as possible to keep the Department informed of the conditions existing in their ranges.

2. With this object in view Medical Officers of Health should arrange in consultation with the Provincial Surgeon for their Inspectors to visit and report on each village in the Inspector's range once every week or ten days.

3. On visiting a village the Sanitary Inspector should gather information as to the amount of malaria prevalent and the progress of the epidemic. He should enter houses and note the number of persons in the family suffering from malaria, the number who have recovered and are able to work, whether there is any difficulty in getting quinine mixture for patients from one of the Department's dispensaries or temporary treatment centres, whether food is available in the house or to what extent there is destitution or starvation in the village as the result of the epidemic. He should take with him a small supply of quinine tablets or mixture so that he may treat patients who are without medicine.

4. The Sanitary Inspector should also note the prevalence of other diseases, such as diarrhoea, dysentery, and pneumonia associated with the outbreak of malaria, report their prevalence to the Medical Officer of Health and take such preventive action as is possible.

5. On return to his station, he should send a brief report on each village visited, to the Medical Officer of Health and a copy to the Provincial Surgeon.

6. He should keep in touch with the Medical Officers, Apothecaries and Relief Committees of the area and let them know the conditions of the villages.

7. He should realize that the success of his work will depend on the energy and resourcefulness which he displays and the amount of help he is able to give the villager.

R. BRIERCLIFFE,
Director of Medical and Sanitary Services.

APPENDIX 7.

Office of the Director of Medical and Sanitary Services,
Colombo, January 3, 1935.

Instructions *re* issue of Malted Milk.

Sir,—I have the honour to inform you that there are a great number of *under nourished children* suffering from *post malarial debility* attending Out-patients' Departments of Dispensaries and Hospitals.

2. The Department is supplying hospitals and dispensaries in the worst affected areas with Malted Milk for issue to such children to restore them to health.

3. A two days' supply of the milk in powder form should be issued in each case by the Medical Officer or Apothecary when he considers it is *required on medical grounds* for the *treatment of the case.* It is not to be considered a relief issue and supplied to every child.

4. Each child will be given three ounces, equal to twelve tea spoonfuls, which is considered sufficient for three small cups for two days; two heaped tea spoonfuls to be used for each cup of Malted Milk.

With the Malted Milk, tins will be supplied for the issue of the milk, with printed directions in Sinhalese for preparation of the milk. As the milk will not keep good indefinitely after the bottle has been opened, no more than two days' supply should be issued at a time for each child.

5. The following hospitals and dispensaries will be supplied with Malted Milk and a copy of this letter is to be sent to the officer in charge of each of these institutions for his information.

I am, Sir,
Your obedient servant,
F. KEYT,
for Director of Medical and Sanitary Services.

APPENDIX 8.

Office of the Director of Medical and Sanitary Services.
Colombo, January 13, 1935.

Standard Tonic Mixture.

A tonic mixture useful for persons convalescent from malaria has been prepared in large quantities at the Civil Medical Stores. It will be issued on requisition not only to hospitals and dispensaries but also to temporary treatment centres, where it may safely be prescribed and dispensed by unqualified persons.

The formula is as follows :—

Iron and Arsenic Mixture.

Liq. Ferri Perchlor	*m*.xv
Syrup Simp	*m*.x
Spt. Chloroform	*m*.v
Liq. Arsenic	*m.ii*
Mag. Sulph	*gr*.x
Aq. Cinnam. ad	oz.i

R. BRIERCLIFFE,
Director of Medical and Sanitary Services.

APPENDIX 9.

Office of the Director of Medical and Sanitary Services,
Colombo, January 24, 1935.

Latrines for Temporary Hospitals and Convalescent Homes.

At the request of the Provincial Surgeon, the Medical Officer of Health should arrange to provide latrines for temporary hospitals and convalescent homes.

2. Bucket latrines will usually be advisable and the standard type of cement squatting plate supported on brickwork should be used. Wherever possible the floor on which the buckets stand should not be of concrete. The bucket should be removable from the back of the latrine. Cadjan screening and roof may be employed.

3. The Provincial Surgeon will recover the cost from the Government Agent's relief fund, and the Medical Officer of Health should see that a competent Sanitary Inspector takes charge of the construction.

4. As temporary hospitals and convalescent homes are likely to be in use for at least six or eight weeks good sanitary latrines must be provided. The temporary pit latrines which certain Medical Officers of Health have allowed to be made are already very insanitary and do not reflect credit on the Department.

5. The Medical Officer of Health must also ensure that a suitable trenching ground is selected, that trenching is properly carried out, that a latrine labourer is employed by the institution, that buckets are cleaned and disinfected and that the latrine is kept in a satisfactory state.

6. One squatting plate latrine for every twelve adult patients is required. Separate latrines should be provided for males and females.

R. BRIERCLIFFE,
Director of Medical and Sanitary Services.

H. AMARASINGHE,
Senior Medical Officer, Headquarters.

APPENDIX 10.

Office of the Director of Medical and Sanitary Services,
Colombo, 18th December, 1934.

Issue of Quinine to Estates.

Sir,—I have the honour to inform you that a number of Estate Superintendents have offered to treat the villages around their estates if they are provided with quinine.

The matter was brought up at the last meeting of the Executive Committee of Health who decided that quinine could be issued free to estates where malaria is very prevalent for this purpose on the following conditions :—

1. That the dispensary and dispenser are placed temporarily under Government control, Government officers being allowed to enter it at any time and issue any orders necessary.
2. That the same records are kept as Government temporary treatment centres and the same daily returns sent.
3. That these arrangements should only be made when they will either obviate the opening of a new Government treatment centre or allow of an existing one being closed.

You will give orders for the issue of quinine to such estates where you consider it necessary and report that you are doing so to the head office. You will take such steps as you consider necessary to see that proper records are kept and quinine is not wasted.

I am, Sir,
Your obedient servant,
R. BRIERCLIFFE,
Director of Medical and Sanitary Services

APPENDIX 11.

No. 3.
Colombo, January 30, 1935.

Conditions for Temporary Hospitals and Convalescent Homes.

Sir,—I have the honour to inform you that experience has shown that certain minimum standards must be enforced if the opening of the above institutions is not to be followed by serious consequences. Before Government Agents or the Medical Department can give them assistance in food, drugs, or medical comforts, &c., they must comply with the following minimum standards:—

(*a*) *Manager*.—For each institution there shall be a capable person appointed as manager. He shall be present at the institution during specified hours every morning and afternoon and should make a round of the wards each night. He should if possible be resident on the premises unless there is a resident doctor or apothecary. He shall be responsible for the administration of the institution, shall keep its accounts, and shall, in particular, ensure that the orders of the doctor or apothecary as regards treatment of patients are strictly carried out, and that patients temperatures are taken and recorded.

(*b*) *Government Inspection*.—The institution shall be open at any time to inspection by the Commissioner for Relief, the Government Agent, and their representatives, and by the Provincial Surgeon and other inspecting officers of the Medical Department.

(*c*) *Supply of Equipment*.—The organization or person conducting the institution shall provide the equipment, *e.g.*, mats, blankets, pillows, check cloths, patients clothing, kitchen equipment and utensils, cups, spoons, lamps, chamber pots, furniture, &c.

(*d*) *Visit of Doctor or Apothecary*.—The patients shall be seen at least once daily by a qualified doctor or apothecary who should prescribe treatment and decide when patients are fit to be discharged. When a private doctor or apothecary is not readily available, requests to the Provincial Surgeon for a daily visit by a Government Medical Officer or apothecary will be favourably considered.

(*e*) *Ward Accommodation*.—The Provincial Surgeon or his representative shall authorize the maximum number of patients which each ward may accommodate and this number shall not be exceeded. The authorized number shall be shown (in paint or chalk) in a prominent place in the ward. The distance between patients mats shall be not less than the width of two mats (*i.e.*, about 4 feet).

(*f*) *Attendants*.—There shall be a day attendant for every twenty patients of each sex and a night attendant for every forty patients of each sex.

(*g*) *Water Supply*.—Where a piped supply is not available there shall be kept in a suitable receptacle in each ward a supply of boiled water for drinking purposes.

(*h*) *Latrines*.—Bucket latrines shall be provided on the scale of one for every twelve adult patients. Where temporary latrines have to be erected, the Provincial Surgeon, if so requested, will get the Medical Officer of Health to arrange construction by a Sanitary Inspector and the cost will be debited to the Government Agent's relief fund. Latrines for males and females are to be kept separate. A suitable ablution place with concrete floor and catch pit must be provided alongside the latrine and a trenching ground arranged. For children, one chamber pot for every six children must be provided.

(*i*) *Supply and Airing of Bedding*.—Mats and blankets are to be spread out in the sun for two hours each day. To permit of this being done, a reserve supply of these articles should be kept.

(*j*) *Patients' Clothing*.—There must be at least one change of clothing per patient. Patients admitted in their ordinary clothing, should on admission be given clean clothing and their own clothes sent to the dhoby.

(*k*) *Washing of Patients*.—Each patient is to be bathed or sponged at least once a day.

(*l*) *Dhoby Arrangements*.—A dhoby should be employed and proper arrangements for the frequent washing of clothes, check cloths, pillow cases, &c., made.

(*m*) *Bad Cases to be sent to Government Hospital*.—Patients developing serious signs or symptoms should be despatched to the nearest Government hospital for treatment at once. For this purpose suitable transport facilities must always be available.

(*n*) *Mortuary*.—There should be a mortuary shed.

(*o*) *Kitchens*.—The manager must see that kitchens and kitchen utensils are kept clean, that kitchen slops are properly disposed of and kitchen refuse properly trenched (if not removed by the local sanitary authority).

(*p*) *Lime Washing*.—Inside walls of wards, kitchens, &c., are to be treated with freshly prepared limewash monthly.

(*q*) *Records*.—An admission and discharge book giving the name, age, sex, and village of each patient shall be kept and each patient shall have a bed head ticket.

Note.—A convalescent home may, for present purposes, be defined as an institution which admits only patients sent from a Government hospital. A temporary hospital admits patients direct.

2. Spare copies of this circular are sent in case you wish to issue them to those starting such institutions. More can be supplied if required.

I am, Sir,
Your obedient servant,
H. P. KAUFMANN,
for Commissioner for Relief.

APPENDIX 12.

Office of the Director of Medical and Sanitary Services.
Colombo, February 14, 1935.

Medical Work in Schools reopened in Bad Malarious Areas.

Sir,—With reference to my letter No. Y 3668 of the 11th instant, I have the honour to state that you are to encourage the reopening of schools in areas which are still badly affected by malaria

2. You should see through the Medical Officers of Health, District Medical Officers, and other officers in charge of dispensaries and treatment centres that a suitable midday meal is provided for the children by the school authorities at the cost of the Government Agent from Relief Funds. A suitable meal is considered to be rice and curry or a bowl of soup made from meat and bones and vegetables where possible.

3. You should also arrange for the daily administration of a dose of quinine before the meal, viz., a grain iv. or v. tablet for children above ten years of age and a grain iii. tablet for children under ten. You will be held responsible for the supply of quinine tablets to the schools and for the issue of instructions.

I am, Sir,
Your obedient servant,
R. BRIERCLIFFE,
Director of Medical and Sanitary Services.

F. KEYT,
for D. M. S. S.

APPENDIX 13. (*a*)

Instructions to Medical Officers of Health regarding the Malaria (Epidemic) Regulations.

1. Medical Officers of Health should, in consultation with the Superintendent, Anti-Malaria Campaigns, prepare a list of villages where work is to be undertaken and draw up programmes of work.

2. The requirements of sections 3 and 5 of the regulations should be carried out as far as they apply to villages. This is to be done at Government expense during the prevalence of the epidemic only, later the regulations are to be enforced according to law.

3. Any proposed work which is likely to interfere with existing works of any other Department should be undertaken only after consulting the local representative of that Department. Public Works Department road drains should not be interfered with except under the guidance of the local Public Works Department representative.

4. A number of villages should be selected to form a unit and work in each unit should be completed within a specified time, *e.g.*, a fortnight.

5. Each unit should have a labour force of ten to thirty men, divided into two gangs if necessary, each in charge of a kangany and both gangs should be supervised by an overseer. The temporary Assistant Sanitary Inspector should generally supervise the working gangs.

6. Medical Officer of Health should see that the programes are carried out according to plan.

7. Medical Officer of Health should see that no new pits are created in borrowing earth for filling existing pits and pools.

8. *Labour.*—Unemployed villagers who are being given relief, should be employed and application for labour should be made by you to the local Relief Committee through the Government Agent before any work is started.

9. *Rates of Pay.*—By arrangement with the Relief Committee. The Supervising Officer (temporary Assistant Sanitary Inspector) will be paid by the Medical Department.

10. *Payments.*—By arrangement with the Relief Committee.

11. *Hours of Work.*—To be arranged in consultation with the local Relief Committee.

12. Medical Officer of Health should obtain daily reports of the work done (giving details and measurements) from the temporary Assistant Sanitary Inspector.

13. A list of pools which cannot be drained or filled up should be made by the Supervising Assistant Sanitary Inspector giving location and extent and forwarded to the Superintendent, Anti-Malaria Campaigns.

14. Bi-monthly progress reports of the work done (1st to the 15th and 16th to 31st) should be forwarded by you to the Superintendent, Anti-Malaria Campaigns, the Provincial Surgeon, and Government Agent or Assistant Government Agent of the area.

15. Careful selection of places which are actual or potential breeding places of *A.culicifacies* should be made. It will be of little use to expend effort and money on the wrong places. *A.culicifacies* breeds in pools of clean clear water in river beds and quarries and in borrow pits, saw pits, brick pits, &c., which are not thickly shaded by vegetation.

APPENDIX 13 (*b*)

Duties of Temporary Assistant Sanitary Inspectors.

1. Abolish by filling in or draining small pools, borrow pits, &c., situated near habitations.

2. *Filling.*—The earth for filling should be obtained from high ground near by without causing fresh borrow pits.

3. *Draining.*—All pits and pools which are difficult to be filled up should be drained or partially filled up and drained.

4. Pools and pits in river and stream beds should be filled up or drained and a free flow in the river should be encouraged by canalising.

5. All drains and channels should be kept free from obstructions that might interfere with the free flow of water.

6. Neglected drains and channels should be improved by training, canalising, and clearing the sides. Public Works Department drains should not be interfered with except under the guidance of the local Public Works Department representative.

7. All discarded water-holding receptacles such as old tins, bottles, coconut husks, &c., should be collected and buried.

8. A check roll of labourers should be kept and pay lists should be prepared as instructed by the Medical Officer of Health.

9. Detailed daily records of work done should be kept—*e.g.*, number of pits filled up and of drains cut giving measurements.

10. A daily report of the work done should be submitted to the Medical Officer of Health.

11. You should supervise the work of the labour force and carry out propaganda work in the villages.

12. You should not be discourteous to any member of the general public in the course of your duties and should enforce discipline and order among labourers you are in charge of.

APPENDIX 14.

An Ordinance for the Prevention of the Breeding and Harbouring of Mosquitoes.

Be it enacted by the Governor of Ceylon, with the advice and consent of the State Council thereof, as follows :—

Short title. 1. This Ordinance may be cited as the Mosquitoes Ordinance, No. of 1933.

Commencement. 2. (1) This Ordinance shall come into operation in such provinces or districts or areas thereof, on such dates as the Governor shall respectively appoint, by orders to be published in the *Gazette*. Provided that except where the spread of yellow fever is apprehended, no such order shall be made unless at least one month's notice of the intention to make the same has been previously given by the Government Agent having jurisdiction in the province, district or area in which the Ordinance is to come into operation, (*a*) by written notice posted up in prominent places within the province, district or area, (*b*) by notification to the Chairman of the Village Committee, if any, (*c*) by notification in the *Gazette*, (*d*) by beat of tom-tom in areas where such manner of notification is customary, and (*e*) by such other means, if any, as he may deem necessary to give publicity thereto.

(2) All orders made under this section shall be laid, as soon as conveniently may be, before the State Council, and if notice of motion to rescind any such order is given at any of the three meetings of the Council next following the date on which the order was so laid, any such order may be rescinded by resolution of the Council passed at any subsequent meeting but without prejudice to anything already done thereunder, and if not so rescinded shall be deemed to be valid.

Interpretation. 3. In this Ordinance, unless the context otherwise requires,—

"anti-mosquito measures" and "anti-mosquito works" mean respectively measures and works for the prevention of the breeding or harbouring of mosquitoes.

"funds at the disposal of the sanitary authority" and "funds at his disposal", where funds at the disposal of the sanitary authority are referred to, mean—

(*a*) in cases where the sanitary authority is the Director of Medical and Sanitary Services, the Government Agent or the Assistant Government Agent, or an officer authorized or appointed by any of them, funds placed at the disposal of such sanitary authority by the Government for the purpose of carrying out the provisions of this Ordinance; and

(b) in cases where the sanitary authority is the Chairman of a local authority, or an officer appointed by him, any portion of the funds at the disposal of such local authority which may be assigned by the local authority under section 13 of this Ordinance for the purpose of carrying out the provisions of this Ordinance.

" house " includes dwelling-house, warehouse, office, shop, school, and any other building in which persons reside or are employed.

" local authority " includes any Municipal Council, Local Board, District Council or Sanitary Board and any Village Committee declared to be a local authority by the Governor with the advice of the Executive Committee of Health.

" mosquito " means the insect commonly so called, that is, an insect belonging to the dipterous family *Culicidae*, and includes its eggs, larvae, and pupae.

" occupier " means the person in occupation of any premises or having the charge, management, or control thereof, either on his own account or as agent of another person, but does not include a lodger.

" owner " includes a co-owner, and the person for the time being receiving the rent, or any part of the rent, of any premises, whether on his own account or as agent, trustee, or receiver, or who would receive the same if the premises were let to a tenant.

" premises " includes houses, buildings and lands of any tenure, whether open or enclosed, whether built on or not, whether public or private, and whether maintained under statutory authority or not, and also includes similarly owned and maintained lighters, barges and other vessels whether on water or not.

" sanitary authority " means (a) the Director of Medical and Sanitary Services or any officer authorized in writing by him throughout the Island, (b) the Chairman of a local authority or any officer appointed in writing by him within the administrative limits of the local authority, or (c) in areas not administered by a local authority, the Government Agent or the Assistant Government Agent or any officer appointed in writing by either of them.

General application of Ordinance, and exceptions.

4. (1) Subject to the provisions of section 5, this Ordinance shall apply to all property of every description whatsoever, to whomsoever belonging, or in or by whomsoever vested or maintained, except tanks, paddy fields, and irrigation channels included in any irrigation scheme, which are hereby exempted from the provisions of this Ordinance except in so far as is provided in sub-section (2).

(2) It shall be lawful for the Governor, by any officer whom he shall appoint for the purpose, to enter upon any tank, paddy field, or irrigation channel included in an irrigation scheme, after reasonable notice served upon the owner thereof, if any, and to carry out or construct therein or thereon at the expense of the Government any such anti-mosquito measures or works as the Governor may deem necessary : Provided that no such measures or works shall be carried out or constructed so as to lessen the utility or bring about the deterioration of any such tank, paddy field, or irrigation channel.

Application of Ordinance to Government premises.

5. In the application of this Ordinance to premises owned by the Government, the following provisions only shall apply :—

(1) Where the premises are occupied as a dwelling-house, the provisions of this Ordinance relating to occupiers shall apply so far as the occupier of the premises only is concerned;

(2) Where the premises are occupied otherwise than as a dwelling-house, or where the premises are unoccupied, the provisions of this Ordinance relating to occupiers shall apply as if the Department of Government in charge of such premises were the occupier thereof.

Entry and inspection by sanitary authority or authorized person.

6. (1) The Sanitary authority or any person authorized in writing by him either generally or specially for that purpose, (in this Ordinance called the " inspecting authority ",) may, at any time between 7 A.M. and 6 P.M., with or without assistants, enter and inspect any premises in order to ascertain whether such premises or any thing therein or thereon are or is in a condition favourable to the breeding or harbouring of mosquitoes :

Provided that no inhabited dwelling-house shall be entered under this sub-section without the consent of the occupier thereof except as mentioned in sub-section (2) and (3).

(2) Where the sanitary authority has certified that a mosquito-borne disease is epidemic in the neighbourhood, the inspecting authority and his assistants may enter and inspect an inhabited dwelling-house on giving to the occupier at least twelve hours previous notice in writing of his intention so to do.

(3) Where the only available access to a yard or compound is through an inhabited dwelling-house the inspecting authority may request the occupier of the dwelling-house to permit the inspecting authority to pass through the dwelling-house into the yard or compound, and in such case it shall be the duty of the occupier of the dwelling-house, on receiving at least twelve hours' previous notice in writing of the desire of the inspecting authority to pass through the dwelling-house, to permit the inspecting authority and his assistants to pass through the dwelling-house into the yard or compound by such route as shall be indicated by the occupier, and to return through the dwelling-house by such route as aforesaid.

(4) Subject to the provisions of this section, the owner or occupier of any premises shall permit the inspecting authority and his assistants to have access thereto or to any part thereof, for the purpose of any such entry and inspection, and shall give the inspecting authority all reasonably necessary information which may be required of him.

General powers of sanitary authority to order action or take preventive measures.

First Schedule

7. The sanitary authority, if he deems it expedient after such entry and inspection that any of the anti-mosquito measures specified in the First Schedule should be carried out in respect of the premises entered and inspected, may either—

(1) by any officer authorized by the sanitary authority in writing either generally or specially for that purpose, carry out with the consent of the owner or occupier of the premises (or without such consent where the introduction of yellow fever is apprehended) any or all of such measures, and the cost of carrying out the same may be met from funds at the disposal of the sanitary authority; or

(2) by notice in writing to be served on the owner or occupier of the said premises, order him within a specified time, not being less than fourteen days from the date of service, to carry out any or all of such measures in respect of the said premises :

Provided that—

(a) the sanitary authority shall not by notice or notices in any one year order anti-mosquito measures to be carried out in respect of the same premises if the cost of such measures will exceed five per cent. of the annual value of the premises;

(b) if the sanitary authority after due inquiry certifies that any such owner or occupier has not the means to meet the cost of complying with any notice under this section, such cost or any part thereof may with the consent of the local authority of the area within which the notice has been served or, in areas not administered by a local authority, with the consent of the Government, be met from the funds at the disposal of the local authority or of the Government, as the case may be; and

(c) it shall be in the discretion of the sanitary authority to decide whether a notice under section 7 (2) should be served on the owner or the occupier of the premises as he may consider just in the circumstances of each case.

For the purposes of this section and the First Schedule, " Sanitary authority " shall not include any officer below the rank of Medical Officer or Medical Officer of Health.

Protection of anti-mosquito works.

8. (1) Where the sanitary authority or any Department of Government or any local authority has constructed, whether before or after the commencement of this Ordinance and whether under the provisions of this Ordinance or not, any anti-mosquito works on any premises, every owner or occupier of such premises who uses the said premises, or permits or authorizes them to be

used, contrary to this Ordinance or any regulation made thereunder or in such a manner as to lessen the efficiency, or to bring about the deterioration of such works, shall be guilty of an offence against this Ordinance.

(2) No prosecution for an offence under this section shall be instituted (*a*) except by the sanitary authority or the Department which constructed the works affected, nor (*b*) until after such owner or occupier, as the case may be, has failed for a period of at least fourteen days to comply with the terms of a notice served on him by the said sanitary authority or Department ordering him to do or not to do any specified act or acts with respect to the said works.

(3) It shall be a good defence for the owner of any premises who is prosecuted under this section to prove that by reason of any cause beyond his control or any written contract (not being a contract made with the intention of evading liability under this section) he has been prevented from entering upon such premises or from using them or permitting or authorizing them to be used in the manner indicated in sub-section (1), unless it can be shown that he has in any way contributed to the commission of an offence under this section by the occupier of the premises.

Appeal.

9 (1) (*a*) The owner of any premises who is of opinion that any notice served on him under section 7 (2) ought to have been served on the occupier of the premises instead of the owner, and (*b*) the occupier of any premises who considers that any such notice ought to have been served on the owner of the premises instead of the occupier, and (*c*) any owner or occupier who considers that the terms of any notice served on him under sections 7 (2) or 8 (2) are unreasonable, unnecessary, or oppressive, or that compliance with the order contained in any notice served on him under section 7 (2) will entail expenditure exceeding the limit provided in section 7 (2) proviso (*a*), may within fourteen days from the service of such notice appeal by petition to the District Court whose decision thereon shall be final.

(2) Every such petition of appeal shall—

(*a*) name the authority or Department which served the notice as respondent to the appeal;
(*b*) state shortly the grounds of appeal;
(*c*) be signed by the appellant; and
(*d*) bear a stamp of five rupees;

and the provisions of sections 339 and 345 of the Criminal Procedure Code, 1898, as to computation of time and procedure respectively, shall apply to every such appeal.

(3) When any such appeal has been lodged in the District Court, the enforcement of the order contained in the notice appealed against shall be stayed pending the hearing of the appeal.

(4) All such appeals shall be taken up before any other business of the court unless special circumstances of urgency in any particular case call, in the opinion of the judge, for a relaxation of this rule.

(5) On the hearing of the appeal, the District Court may hear such evidence as may be necessary, and may—

(*a*) confirm, vary, or rescind the order contained in the notice, and where such order is confirmed or varied shall make a further order specifying the time within which the order so confirmed or varied is to be complied with
(*b*) make any further order that it may deem expedient; and in such case the time within which such order is to be complied with shall be specified therein; and
(*c*) make such order as to costs as it may think fit, not exceeding thirty rupees.

Failure to comply with notice or order.

10 (1) Every owner or occupier of any premises who within the time specified in any notice served on him under section 7 (2) or 8 (2) in respect of the said premises, fails to comply with such notice or to appeal therefrom shall, for each day of such failure be guilty of an offence against this Ordinance.

(2) Every owner or occupier of any premises who fails to comply with any further order of the District Court made on appeal under section 9 (5) relating to the said premises, within the time specified in such order, shall be guilty of an offence against this Ordinance.

Enforcement of notice by sanitary authority.

11 (1) Upon the conviction of any owner or occupier for an offence under sections 8 or 10 the authority or Department which served the notice on the owner or occupier prior to his prosecution may, by himself or itself or by any person authorized by him or it in writing either generally or specially for that purpose, enter into or upon the premises in respect of which the notice was served with such assistants and things as are necessary, and may carry out all measures necessary to comply with the said notice, or with any further order made by the District Court on appeal.

(2) Any expenses incurred by such authority or Department in carrying out the said measures under sub-section (1) shall be recoverable in the manner hereinafter provided from the owner or occupier who has been convicted.

(3) If the amount of such expenses is not, within fourteen days after demand, paid to the said authority or Department by the owner or occupier who has been convicted, or if any instalment thereof (where the authority or Department allows payment by instalments) is not paid on or before the due date, it shall be lawful for the authority or the Department by himself or itself or by any person authorized as aforesaid—

(*a*) to seize any property whatsoever belonging to the said owner or occupier, wheresoever the same may be found within the town, district, or area in which the said premises are situated; and
(*b*) to sell the same, or so much thereof as may be necessary to cover the amount due and the costs of seizure and detention, by public auction not less than twenty-one days from the date of seizure, if the said amount and costs are not sooner paid.

(4) No action shall be taken under this section against any owner or occupier who has appealed to the Supreme Court against a conviction under section 8 (1) or 10, unless and until such conviction is upheld on appeal.

Loans by sanitary authority

12 (1) It shall be lawful for the sanitary authority out of the funds at his disposal on the application of the owner of any premises to make a loan at such rate of interest not exceeding nine per centum per annum as may be agreed upon for the purpose of carrying out or constructing any anti-mosquito measures or works in or on the said premises, if the cost of such works or measures will exceed five hundred rupees and the value of the premises will be enhanced by reason thereof.

(2) The amount of such loan together with any interest due thereon shall be a first charge upon the premises in question.

Power for local authority to assign funds for carrying out the Ordinance.

13. Notwithstanding the provisions of any written law to the contrary, it shall be lawful for any local authority from time to time to assign any portion of the funds at its disposal for the purpose of carrying out the provisions of this Ordinance; and any such funds as assigned may, with the approval of the local authority, be expended for any of such purposes by the Chairman of the local authority, or by any officer appointed by him, in his capacity as sanitary authority.

Agreement for reservation.

14. When any anti-mosquito works have to be constructed by the sanitary authority on any premises, the sanitary authority may enter into and execute an agreement with the owner of the said premises that in consideration of the benefit accruing to the owner by reason of the works any portion of the premises shall be reserved to the sanitary authority after the conclusion of the works for the purpose of keeping the said works in repair or preserving them.

Protection for authority, &c.

15. No civil or criminal proceeding shall be instituted against any sanitary or local authority or any of the officers of such authority or any person authorized or employed by such authority to perform any act or do any work, in respect of any act *bona fide* done or omitted to be done for the purpose of carrying out the provisions of this Ordinance or any regulations made thereunder.

Sanitary authority and officers, &c., thereof to be public servants.

16. Every sanitary authority, and every officer, servant, workman, or other person authorized, engaged, or employed by any sanitary authority shall in and during the exercise of any or his powers, or the execution of any of his duties, under this Ordnance, be deemed to be a public servant within the meaning of the Ceylon Penal Code.

Service of notices.

17 (1) Any notice which by this Ordinance or any regulation made thereunder is required or authorized to be served on the occupier of any premises shall be written in English, Sinhalese, and Tamil, and shall be deemed to be duly served:—

(*a*) if it is served personally on the occupier; or
(*b*) if it is sent by registered post addressed to him at the premises; or
(*c*) if it is left at the premises with some adult servant or member of his family.

(2) Any notice which by this Ordinance or any regulation made thereunder is required or authorized to be served on the owner of any premises shall be written in English, Sinhalese, and Tamil, and shall be deemed to be duly served—

(*a*) if it is served personally on the owner; or
(*b*) if it is sent by registered post addressed to the owner at his usual or last known place of abode; or
(*c*) where the owner or his address is unknown, if it is left at the premises and a copy thereof is posted up and kept posted up for fourteen days at the Kachcheri of the district in which the premises are situated and is also published on two occasions, separated by four days, in a newspaper circulating in the district.

Penalty.

18. Every person who is guilty of an offence against this Ordinance or who contravenes any of the provisions of this Ordinance or of any regulation made thereunder or who fails to perform any duty imposed upon him by this Ordinance or any such regulation shall, upon summary conviction by a Police Magistrate or Municipal Magistrate having jurisdiction, be liable to a fine not exceeding thirty rupees and on a second or subsequent conviction to a fine not exceeding fifty rupees, or to imprisonment of either description for any term not exceeding one month, or to both such imprisonment and fine.

Regulations.

19 (1) It shall be lawful for the Governor, with the advice of the Executive Committee of Health, to make regulations for any or all of the following purposes:—

(*a*) for carrying out the anti-mosquito measures contained in the First Schedule and for amending, rescinding, or adding to the said Schedule;
(*b*) for the protection of anti-mosquito works; and
(*c*) for carrying into effect the provisions of this Ordinance.

(2) No regulation made under this Ordinance shall have effect unless it has been approved by the State Council and ratified by the Governor. Notification of such approval and ratification shall be published in the *Gazette* and no regulation shall come into operation until the date of the publication of such notification.

Amendments. Second Schedule.

20. The enactments set out in the first and second columns of the Second Schedule are hereby amended to the extent set out in the third column thereof.

(Sections 7 and 19.)

FIRST SCHEDULE.

Anti-mosquito measures.

1. The removal and disposal in the manner specified by the sanitary authority of all discarded articles, things, receptacles, or vessels capable of holding water. — Discarded articles, &c.

2. The emptying every seven days, the screening with wire gauze or the treatment in any other manner specified by the sanitary authority of barrels, tanks, earthernware vessels, or other articles liable to breed or harbour mosquitoes. — Wooden barrels, cement tanks, &c.

3. The cleaning every seven days, alignment, or piercing of gutters. — Gutters.

4. The oiling every seven days of gullies. — Gullies.

5. The repairing of built drains, or the oiling of the same every seven days. — Built drains.

6. The emptying or oiling every seven days of catchpits and the oiling every seven days of cesspits. — Cesspits and catchpits.

7. The filling up of abandoned built-wells, and the introduction of larvivorous fish (to be supplied without charge by the sanitary authority) into builtwells in use, or the treatment of such wells in any other manner specified by the sanitary authority. — Built-wells.

8. The filling up, the oiling every seven days, or the treatment in any other manner specified by the sanitary authority of unlined wells, trenches in coconut land, silt traps, excavations in quarries, and all pits holding water or capable of doing so. — Unlined wells, trenches, &c.

9. The cleaning and grading of, the application of oil or other larvicide to, or the treatment in any other manner specified by the sanitary authority of streams, unlined drains, and culverts. — Streams, &c.

10. The filling up, draining, or treatment with larvicide every seven days of swamps and water-logged areas. — Swamps.

11. The cutting down and removal of tree stumps, bamboo stumps, rank-grass, and undergrowth liable to breed or harbour mosquitoes. — Tree stumps and undergrowth.

12. The filling up of tree holes found to be breeding mosquitoes. — Tree holes.

13. The destruction of mosquitoes by fumigation or other chemical means. — Mosquitoes.

(Section 20.)

SECOND SCHEDULE.

Amendments.

Column 1. No. and year of Ordinance	Column 2. Short title.	Column 3. Nature of Amendment.
No. 18 of 1892	The Small Towns Sanitary Ordinance, 1892	Section 9E (2) (*r*) is amended so as to read— " (*r*) For the destruction of disease-bearing insects other than mosquitoes ".
No. 11 of 1920	The Local Government Ordinance, No. 11 of 1920	Section 168 (10) (*o*) is amended so as to read— " (*o*) The destruction of disease-bearing insects other than mosquitoes ".

OBJECTS AND REASONS.

This Bill is based on certain recommendations of the Anti-Malaria Advisory Committee and has as its object the provision of legislation for preventing the breeding of mosquitoes and for the destruction of mosquitoes. There are at present no direct statutory powers to deal with mosquitoes, except in virtue of by-laws made under the Small Towns Sanitary Ordinance, 1892, and the Local Government Ordinance, No. 11 of 1920; and, in the interests of the health of the community generally, it is now considered that a comprehensive enactment is required.

2. By clause 1 the Ordinance will come into operation only in such Provinces, districts, or areas as the Governor may order. Such orders may ordinarily be made only after adequate notice and may be rescinded by a resolution of the State Council.

3. The Ordinance will in the main be administered by the "sanitary authority" who is defined in clause 3, but local authorities (clause 3) and Government Departments are also given certain powers (clauses 8, 9, and 11).

4. Clause 4 (1) provides for the general application of the Ordinance, except in the case of tanks, paddy fields, and irrigation channels, for which special provision is made in clause 4 (2).

5. Clause 5 deals with the application of the Ordinance to premises owned by the Government, dividing such premises into (1) those occupied as dwelling-houses, in which case the provisions of the Ordinance relating to occupiers will apply, and (2) those which are unoccupied, or occupied otherwise than as dwelling-houses, in which cases the Government Department in charge of such premises will be treated as the occupier.

6. Clause 6 gives the necessary powers of entry and inspection to the sanitary authority while protecting the occupants of dwelling houses from unnecessary intrusion.

7. Clause 7 gives the sanitary authority power to bring into operation in respect of any premises the anti-mosquito measures set out in the First Schedule which may be found necessary—either by itself carrying them out with the consent of the owner or occupier, or by requiring the owner or occupier to carry them out. But no person can be required under this clause to spend in any one year more than five per cent. of the value of the premises affected, and if the sanitary authority certifies that any person is financially unable to meet the expense of complying with a notice, the work may be carried out at the expense of the local authority or the Government.

8. Clause 8 imposes a duty on the owner or occupier of premises on which any anti-mosquito works have been constructed to use the premises properly; but no prosecution is to be instituted under this clause until the owner or occupier has been served with a notice telling him what to do or not to do, and he has failed to comply with the notice.

9. Clause 9 gives a right of appeal to the District Court from any notice, and sets out the powers of the District Court on appeal.

10. Failure to comply with a notice or with an order of the District Court is made an offence by clause 10, and clause 11 provides the machinery for enforcing what is required by a notice or an order by seizure and sale of property belonging to the defaulter.

11. Clause 12 authorizes the sanitary authority to make loans for anti-mosquito purposes in certain circumstances, and clause 13 makes provision for a local authority to assign funds for the purposes of the Ordinance, and for the expenditure of such funds by the Chairman in his capacity as sanitary authority.

12. Clause 14 empowers the sanitary authority to make an agreement with the owner of premises where anti-mosquito works have been constructed, for the reservation of a portion of the premises for the use of the sanitary authority so as to enable the authority to keep the works in order.

13. Clauses 15, 16, and 17 respectively provide for the protection of sanitary authorities and others, the status of such authorities as public servants within the meaning of the Ceylon Penal Code, and the service of notices.

14. Clauses 18 and 19 provide a penalty for breaches of the Ordinance and regulations and a power to make regulations.

15. Clause 20 and the Second Schedule amend the Small Towns Sanitary Ordinance, 1892, and the Local Government Ordinance, No. 11 of 1920, by removing the power to make by-laws for the prevention of malaria and the destruction of mosquitoes.

T. B. PANABOKKE,
Minister for Health.

The Ministry of Health,
Colombo, October 7, 1933.

APPENDIX 15.

Malaria (Epidemic) Regulations, 1935.

[Extract from the "Ceylon Government Gazette" No. 8,103 of February 8, 1935.]

The Quarantine and Prevention of Diseases Ordinance, 1897.

Regulations under sections 4 and 5 of the Quarantine and Prevention of Diseases Ordinance, 1897, made by the Governor by virtue of the powers vested in him by the said section 4 and by Article 93 of the Ceylon (State Council) Order in Council, 1931.

By His Excellency's command,
T. B. PANABOKKE,
Minister for Health.

The Ministry of Health,
Colombo, February 8, 1935.

REGULATIONS.

1. *Short Title.*—These regulations may be cited as the Malaria (Epidemic) Regulations, 1935.

2. *Interpretation.*—In these regulations unless the context otherwise requires—

"land" includes any house, building, or structure, and the bed of any pond, tank, lake, water-course, channel, canal, or stream, situated thereon;

"occupier" means the person in occupation of any land or having the charge, management, or control thereof, whether on his own account or as agent of another, but does not include a lodger;

"proper authority" means the Director of Medical and Sanitary Services acting through hte Provincial Surgeon of a province or the Medical Officer of Health of a district for the Island as a whole; or in any area within the administrative limits of a Municipal Council, Urban District Council, Local Board, or Sanitary Board the Chairman of that Council or Board, and in any area where there is no such Council or Board, the Government Agent or Assistant Government Agent within whose province or district that area is situated.

3. *Ordinary Anti-Malarial Measures.*—It shall be the duty of the occupier of any land to take or adopt each of the following measures for preventing the breeding of mosquitoes upon that land:—

(i.) the removal and destruction or other effective disposal of all open tins, bottles, vases, boxes, coconut shells, split coconuts, and other articles capable of holding accumulations of stagnant water;

(ii.) the maintenance of all gutters, downpipes, and drains, clear of all obstruction to the flow of water;

(iii.) the maintenance of all cisterns, tanks, and other receptacles for water in good repair, keeping them at all times so closed or covered as to make them mosquito-proof and emptying them at least once every week;

(iv.) in the event of there being on the land any artificial pond so constructed as to be capable of being emptied, emptying it at least once every week;

(v.) the maintenance of all water-courses, streams, canals, or channels passing through the land, in a condition capable of preventing the formation of pools along their course;

(vi.) the draining of any casual collection of water in any court-yard, garden, or other part of the land; and
(vii.) the removal of scrub or undergrowth and of all vegetation, other than that grown for the purposes of food or of ornament, from all that part of the land which is within a radius of fifty yards of any building or structure used as a human dwelling.

4. *Right of Entry for Purposes of Inspection.*—It shall be lawful for the proper authority, or any officer or officers authorized by him thereto in writing, to enter any land between the hours of sunrise and sunset and to inspect any part of it, for the purpose of ascertaining—

(i.) whether the requirements of regulation 3 have been complied with by the occupier thereof; or
(ii.) what measures, if any, are necessary for destroying mosquitoes and preventing the further breeding of mosquitoes therein.

5. *Special Anti-Malarial Measures.*—(1) It shall be lawful for the proper authority, after such inspection as he may deem necessary by notice in writing to direct the occupier of any land to take or adopt with respect to that land, within such time as may be specified in the notice, any one or more of the following precautions or measures:—

(i.) the repair of all gutters, downpipes, and drains;
(ii.) the construction or reconstruction of any cistern, tank, or artificial pond required by the occupier, in such manner as may make it capable of being emptied periodically;
(iii.) the temporary draining and the clearing of any such cistern, tank, or pond, and the closing thereof when it is no longer required by the occupier;
(iv.) the filling up or the draining of any disused well, cesspit, pond, or other collection of water;
(v.) the filling up of natural pits and hollows and low-lying parts of the land;
(vi.) the filling up, or the draining, or the treatment with larvicide, of swamps and water-logged parts of the land.

(2) Service of any such notice may be effected upon an occupier either personally or by leaving the notice with some adult person living with the occupier or by posting up the notice on some conspicuous part of the land.

(3) It shall be the duty of every person so served with a notice, to comply with the directions set out within the time specified therein.

6. *Arrangements during Temporary Absence of Occupier.*—It shall be the duty of the occupier of every land to make arrangements for due compliance with the requirements of regulation 3 or with the directions set out in any notice served on him under regulation 5, during any period when he is temporarily absent from the land; and no plea of temporary absence shall be accepted as a lawful excuse for any neglect, failure, or default with which he may be charged.

7. *Owner's Liability during Interval between Tenancies.*—The owner, lessee, or other person by whatever right entitled to the rent or produce of any land which is habitually let or sub-let to other persons, shall be held liable for any neglect or failure to comply with the requirements of regulation 3 during the period intervening between the termination of one tenancy and the commencement of the next tenancy.

8. *Liability of Co-owners in Joint Occupation.*—Where any land is in the joint occupation of two or more co-owners, each of the co-owners shall be severally liable for any neglect or failure to comply with the requirements of regulation 3 or with the directions set out in any notice duly served under regulation 5 on any one of them.

9. *Right of Entry for carrying out Works.*—It shall be lawful for the proper authority, or any officer or servant authorized thereto by him in writing, to enter any land between the hours of sunrise and sunset for the the purpose of carrying out on any part thereof, at the expense of the proper authority, such works or measures as may be necessary for destroying mosquitoes and for preventing the further breeding of mosquitoes upon the land.

10. *Resistance to Officers or Servants.*—No person shall knowingly or wilfully resist or obstruct the proper authority or any authorized officer or servant of the proper authority in the lawful exercise of his duty under any of these regulations.

11. These regulations shall be in force for a preiod of six months from the date of their publication in the *Gazette.*

APPENDIX 16.

Report on 1906 Epidemic.

Sessional Paper No. XL. of 1906—Malaria Fever in the Low-country—Report No. 286.

Report of the Principal Civil Medical Officer on the Hon. Mr. E. Rosling's motion for a statement showing what steps, if any, have been taken to cope with the abnormal amount of sickness, especially in the low-country.

The outbreak of malarial fever is confined almost entirely to the Western, Central, Sabaragamuwa, parts of the North-Western and to a small part of the Southern Provinces.

2. The hospitals and Government dispensaries in those Provinces number 178. The estate dispensaries in those Provinces number 97. The total number of medical institutions is therefore 275, at every one of which the stock of fever medicines has been well kept up and a large number of sick are being treated.

3. In addition, 29 persons are employed on itinerating duty to distribute, quinine, &c., to those patients who cannot attend at the dispensaries. Quinine and other medicines have been supplied free of cost to philanthropic individuals who have volunteered to treat the sick in their immediate neighbourhoods.

4. Temporary extra ward accommodation has been asked for at the following hospitals to meet the overcrowding:—Panadure, Avissawella, Kegalla, Ratnapura, Balangoda, Lunugala, Nawalapitiya, and Teldeniya, and more permanent wards for Matale and Karawanella.

5. The amount of quinine issued has been very large—from January to date 3,043½ lb. as against 2,036 lb. during the same period last year. In June alone of this year 612½ lb. were issued.

6. His Excellency the Governor, anticipating the fever season gave orders that all children attending schools and all the inhabitants of villages in malarious districts were to be given quinine twice a week as a preventive measure. The arrangements for this large distribution and administration of quinine have taken some little time to complete, but they are now nearly ready to be put into operation.

A. PERRY,
Principal Civil Medical Officer and Inspector-General of Hospitals.

Colombo, July 17, 1906.

APPENDIX 17.

Report on the Epidemic to the Eastern Bureau.

The worst epidemic of malaria yet recorded in Ceylon started in October following unusual climatic conditions.

The part of the Island affected is the south-west quadrant or the wet zone, which normally receives the rains of the south-west monsoon. These rains failed to a great extent and there was a prolonged drought from May to September followed by heavy rain for a few days at the onset of the north-east monsoon in October.

2. The epidemic started in the valley of the Maha-oya at the beginning of September in villages round Alawwa, Rambukkana, and Polgahawela. The attendance at the dispensaries in these centres rapidly rose to eight or ten times the normal. By the end of October the area of the outbreak had extended up and down the river and in November it spread rapidly in all directions. The whole of the southern part of the North-Western Province except the coastal fringe, the Kegalla District of the Sabaragamuwa Province, in which the Maha-oya and its principal tributaries take their rise, and the parts of the Central and Western Provinces bordering on the North-Western Province were affected by the end of November. In the Western Province, about this time, an increased attendance for malaria was noticed at the dispensaries in the Kelani river valley where there had been a minor flood five or six weeks previously. The epidemic had reached its maximum intensity in these areas by the middle of December and in many of the villages and smaller towns almost every person had been infected,

3. The disease continued to invade new areas but in a much less intense form. The coastal fringe of the North-Western Province and Western Province became affected and by the third week of December areas bordering on the northern boundary of the Southern Province were reporting cases. Infections have occurred in a number of the coastal towns of the Western Province which for many years have been entirely free from malaria.

4. About one-fifth the area of Ceylon has been affected but this area is the most densely populated part of the Island and contains approximately 3,500,000 of Ceylon's total population of 5,500,000. There have probably been about half a million persons attacked by the epidemic.

5. At the start of the outbreak the majority of the cases were benign tertian in type but later subtertian malaria began to be very much in evidence and the death rate, particularly among children, has been moderately high. In the North-Western Province and in parts of the Kegalla District where distress already prevailed as the result of the droughts and crop failures, the disease has caused much suffering.

6. The carrier of the disease throughout the epidemic has been *Anopheles culicifacies.*

7. The numbers seeking treatment in hospitals and dispensaries were so large that the staffs of these institutions had to be strengthened and the branch and visiting stations which hitherto had been opened only once or twice a week, were converted temporarily into central dispensaries open every day and placed in charge of resident officers. Wherever a badly affected village or group of villages was situated too far from medical aid, a temporary malaria treatment centre was opened. The objective was to provide these treatment centres in such numbers in the epidemic areas that no person had to travel further than three miles at most to get his supply of medicine. Fortunately a sufficient supply of doctors, apothecaries, medical and apothecary students, and dispensers volunteered for temporary malaria duty in the Department. The Sanitary Inspectors were employed to keep the Department informed as far as possible of the conditions existing in their ranges and were instructed to visit each village once in every week or ten days. On visiting a village, the Saniary Inspector made a census of the number of cases and noted the progress of the epidemic. He entered houses and estimated the number of persons in the family suffering from malaria, the number of persons who had recovered and were able to work. Where any patient was unable to attend a treatment centre or send for quinine mixture, he made arrangements for the supply of medicine. He also inquired whether food was available in the house or to what extent there was destitution or starvation in the village as the result of the epidemic.

8. The standard form of dispensary treatment has been a two days supply of quinine mixture—for adults seven and half grains of quinine bisulphate to the dose and three doses a day.

9. The Department's reserve stocks of quinine were rapidly being exhausted since some 300 lb. a day were required. Large supplies were ordered from England and smaller supplies from Java and pending their arrival the Government of India kindly allowed 10,000 lb. from its reserve stock to be purchased by the Ceylon Government.

10. The State Council during the second week of December opened a relief fund to which Rs. 100,000 of Government money was voted. Since then Government has provided another Rs. 100,000 and voluntary subscriptions are also being added. Allocations from the fund are made to the Government Agents of the affected Provinces and they have been arranging the distribution of food to the sufferers through Local Relief Committees and Sub-Committees. Local bodies such as Urban District Councils and Village Committees have also provided relief and locally great assistance has been given by the spontaneous efforts of influential residents.

R. BRIERCLIFFE,
Director of Medical and Sanitary Services.

Office of the Director of Medical and Sanitary Services,
Colombo, December 26, 1934.

APPENDIX 18—PRESS COMMUNIQUES.

Press Communique.

MALARIA SITUATION.

The worst affected areas continue to be those on the banks of Maha-oya round Rambukkana, Alawwa, Polgahawela, Giriulla, Ambepussa, and Mirigama.

In the North-Western Province the areas round Dandagamuwa, Hettipola, Narammala, Kurunegala, Nikaveratiya, and Maho continue to be severely affected. In the coastal area the numbers are daily increasing, especially at Chilaw and Marawila.

In the Central Province, the worst areas are those bordering the North-Western Province and Kegalla District, viz., Galagedara and Kadugannawa. Katugastota is also badly affected. In the villages round about Gampola, malaria is very prevalent. In Kandy the situation is not serious. In the northern part of Kegalla District, there is as yet no improvement, but the daily number of cases is not increasing. Kegalla hospital and the dispensaries at Mawanella, Warakapola, Pindeniya, and Nelundeniya are still working at full pressure, but further south at Undugoda, Karawanella, and Eheliyagoda the number of out-patients is decreasing. There is little evidence of increased incidence in Ratnapura District, except at Kuruwita and Pelmadulla, where the dispensary attendance is much larger than usual.

In the Western Province the worst affected areas along the Kelani river are the villages extending from Kaduwela to Avissawella on both banks of the river. The disease is prevailing in a highly epidemic form at Gampaha, Watupitiwala, Padukka, Pugoda, Dompe, Radawana, and Pannipitiya. The epidemic in the Western Province has now spread south. In certain parts of Colombo infections have been reported but there is nothing in the nature of an epidemic.

In other parts of the Island malaria is more prevalent than usual at this season of the year particularly in the North-Central Province and in the Southern Province around Tangalla, Walasmulla, and Ambalantota.

The following table shows the number of malaria cases treated at various centres:—

Place.	Date.	No. of Cases.
Western Province—		
Moratuwa	18.12.34	196
Panadure	17.12.34	645
Avissawella	16.12.34	529
Gampaha	do.	383
Wathupitiwela	do.	428
Kotadeniyawa	15.12.34	501
Kosgama	do.	315
Veyangoda	16.12.34	438
Weweldeniya	15.12.34	397
Ingiriya	16.12.34 17.12.34	111 183
Horana	17.12.34	483
Bandaragama	Average	250
Padukka	17.12.34 18.12.34	532 420
Southern Province—		
Uduvila	16.12.34	224
Province of Sabaragamuwa—		
Kuruwita	16.12.34	306
Pelmadulla	do.	367
Kegalla	do.	1,006
Mawanella	do.	809
Nelundeniya	16.12.34	664
Pindeniya	do.	336
Rambukkana	do.	458
Warakapola	do.	564
Central Province—		
Paldeniya	16.12.34	294
Kadugannawa	17.12.34	673
Teldeniya	do.	386
Gampola	do.	557
North-Western Province—		
Ridigama	17.12.34	221
Maho	do.	338
Alawwa	16.12.34 17.12.34	489 558
Chilaw	16.12.34	317
Kurukotuwa	15.12.34	365
Dandagamuwa	15.12.34	1,037
Narammala	16.12.34	604
Rilgahawela	17.12.34	700
Makandura	16.12.34	1,800
Potuhera		950
Katupitiya		460

Office of the Director of Medical and Sanitary Services,
Colombo, December 19, 1934.

Press Communique.

In view of the incorrect statements which have appeared in certain sections of the press regarding the dosage of quinine prescribed by the Department of Medical and Sanitary Services during the present epidemic of malaria, the use of plasmoquine preparations and atebrin, and the Government's stocks of quinine, the following information is given.

The standard quinine mixture used in Government Hospitals and Dispensaries consists of 7½ grains of quinine bi-sulphate in each adult dose and three doses a day, *i.e.*, 22½ grains, are prescribed. Formerly quinine sulphate was used by the Department and the dose was 5 grains three times a day.

The Department has experience of the use of plasmoquine preparations in rural areas in Ceylon. The drug has been used in connection with the Minneriya Colonization Scheme and experimentally in certain villages in areas where malaria is hyperendemic. For this type of work it has been found to offer no advantages over quinine, while the alarming symptoms to which it sometimes gives rise are a contra-indication to its use in mass treatment. Plasmoquine and atebrin are both being extensively used for the treatment of malaria in Government hospitals where their effects can be carefully watched, but the Department is not prepared to allow their use in its dispensary work.

Various suggestions have been received by the Department that attempts should be made to distribute quinine for prophylactic use on a large scale. Experience both in Ceylon and other countries has shown that this measure does not succeed in preventing malaria. The Department's hospital and dispensary staffs who are constantly exposed to the risk of infection in the epidemic areas are given 10 grains of quinine bisulphate each evening, and individual members of the public who live in these areas might follow a similar procedure. It should be realized, however, that 10 grains of quinine a day is a therapeutic rather than a prophylactic dose.

It has been the practice of the Department always to keep in the Civil Medical Stores a reserve supply of quinine equal to ten months normal requirements and more than 7,000 lb. were available at the beginning of November. The heavy demand occasioned by the epidemic had reduced the stock to less than 800 lb. on the 20th December. Five months normal supply of quinine were issued in the first twenty days of December, but the Department has not in any way restricted its issues of the drug to its hospitals and dispensaries, since large supplies were on the way to Ceylon from England, Java, and India.

The first consignment of 2,000 lb. from the Government of India was received on December 20 and a further 8,000 lb. from Calcutta is on the way. 1,000 lb. from Java are due in Colombo on December 26 and 7,000 lb. from England on January 6. These large stocks are sufficient to meet all eventualities for the next two or three months.

Office of the Director of Medical and Sanitary Services,
Colombo, December 21, 1934.

Press Communique.

During the past few days the epidemic of malaria has in most areas shown signs of abatement.

The numbers of new patients seeking treatment have diminished, but old cases are being treated in large numbers and still require much attention and help.

The southern part of North-Western Province and parts of Kegalla District continue to be the most severely affected areas.

The Western Province is badly affected in the area from Kelani Valley to Maha-oya river. South of this the outbreak both as regards the numbers affected and the severity of the disease has been much less serious.

The only parts of Central Province that have been badly affected are those bordering on Kegalla and Kurunegala Districts, although the Teldeniya, Matale, and Gampola areas have been moderately affected.

New areas are still on the increase towards the south and the edge of the epidemic has now crossed the Bentota river, but the odtbreaks in these parts have not so far been serious.

Malaria in North-Central Province is not much worse than usual at this season of the year.

In the south of the Island, malaria is very prevalent in Hambantota District.

Office of the Director of Medical and Sanitary Services,
Colombo, December 25, 1934.

Press Communique issued by the Minister for Health with the Concurrence of the Executive Committee of Health.

A meeting of the Executive Committee of Health was held this morning to consider what steps had been taken to deal with the present malaria epidemic and to consider what further steps were necessary.

At the request of the Hon. Minister the Director of Medical and Sanitary Services gave a statement of the history of the epidemic and of the present position. The Director stated that it had been realized during the drought that it was probable that there would be more malaria than usual after the October rains had set in, but that it was quite impossible to foresee an epidemic of the dimensions of the present one. The Provincial Surgeons had been instructed in October to watch carefully certain areas where it was thought that malaria was likely to be prevalent. There had been a sudden and remarable rise in the number of patients in the Polgahawela area towards the end of November and thereafter hospitals and dispensaries over an extending area showed large increases up to the third week in December. Since then there had been a very gradual decline. The peak of the present epidemic was over but a great deal remained to be done to build up the health of those who have been affected and to prevent relapses.

Consideration was given to the alarming reports which have appeared in the press both in Ceylon and outside, in particular the reports of the deaths which had occurred. It was explained that every effort is being made by the Registrar-General to obtain figures of the deaths which had occurred outside hospitals. The Director of Medical and Sanitary Services gave the percentage of deaths to cases treated in hospitals, which are the only death figures yet available to the Department, which indicated that the mortality was not high for malaria in epidemic form. It was decided that in order to check inaccurate reports press communiques should be issued from the Ministry of Health twice a week.

The question of house to house visiting was discussed. It was agreed that the attempt made to treat patients by means of itinerating officers at the beginning of the epidemic was not nearly as effective as the present system of providing treatment centres in every group of villages. The Director stated that arrangements had been made for Sanitary Inspectors to visit all houses within their ranges, to administer quinine to any urgent cases, to notify the headmen or relief committee of cases where food is required and to arrange for those requiring medical attention to be taken to the hospital or dispensary. These arrangements were approved and the Director was given authority to engage suitable men to supplement the Sanitary Inspectors in this work.

The question whether application should be made for doctors from India was considered. The Committee was very grateful for any offers made, but it thought that there was no immediate necessity for obtaining doctors from abroad. They wished to reconsider this after experience has been gained of the working of the extra arrangements made at this meeting.

The question of opening temporary hospitals was discussed. The Director of Medical and Sanitary Services stated that a temporary hospital had been opened at Polgahawela and that at nine hospitals temporary wards had been constructed. In all hospitals where required, extra beds were provided. He stated that he had considered the opening of numerous temporary hospitals, but had preferred extending existing ones since he could not obtain the necessary staff of nurses and trained attendants to give proper treatment at temporary hospitals. The Executive Committee agreed with the Director and preferred that arrangements should be made for all cases requiring hospital treatment to be conveyed at Government expense to existing Government hospitals.

The Committee approved the arrangements made by the Director of Medical and Sanitary Services for providing drugs from the Department to the convalescent homes which had been opened by voluntary workers, and recommended that financial assistance should be given to these homes from the malaria relief fund.

The question of the drugs supplied to treatment centres was considered. It was pointed out that there had been criticism that at treatment centres only quinine and Epsom salts were available. The Committee, however, agreed with the Director that it was inadvisable to supply other drugs to treatment centres which were normally in the charge of medically unqualified persons, and preferred that arrangements should be made for patients who required other treatment to be conveyed to hospitals. The Committee agreed that plasmoquine and atebrin should only be used as at present at hospitals under proper medical supervision. The Committee approved the action taken by the Director in providing malted milk or Lactogen at dispensaries to be given on medical prescription to children who required it. The Director stated that a tonic mixture was also being sent out.

The Director of Medical and Sanitary Services stated that a full report on the epidemic would be prepared in due course and the Committee agreed that it should be issued as a Sessional Paper. It was considered that the Department had in it at present men with sufficient knowledge of malaria and experience of malaria in Ceylon to analyse the causes of the epidemic and suggest preventive measures for the future.

The Committee decided that the Mosquito Ordinance should be reintroduced in the State Council.

The Ministry of Health,
Colombo, January 10, 1935.

Press Communiqué issued by the Ministry of Health.

The amount of malaria throughout the epidemic area has continued to decrease slowly since the third week of December.

In the Deduru-oya basin, in which Galagedara, Mawatagama, Kurunegala, Batalagoda, Hiripitiya, Wariapola, Maho, and Nikaweratiya hospitals and dispensaries are situated, the decrease has been very considerable and the number of patients is now nearly a third less than it was three weeks ago. The hospitals and dispensaries in the coastal area between Mundel and Chilaw are also registering many fewer cases. In the upper part of the Maha-oya basin, which includes the hospitals and dispensaries of Kadugannawa, Mawanella, Aranayake, Undugoda, Pindeniya, Nelundeniya, Rambukkana, and Polgahawela, the decrease started at the end of the second week of December and has amounted to about 20 per cent. of the number of patients. In the middle area of the Maha-oya basin the decrease on the northern bank, which includes the hospitals and dispensaries of Narammala, Giriulla, Dandegamuwa, and Makandura, has been even greater and has amounted to nearly 40 per cent., but to the south of the river the area including Warakapola, Mirigama, Watupitiwela, Gampaha, Veyangoda, and Minuwangoda shows a decrease of only about 10 per cent. In the Maha-oya coastal area the peak of the outbreak was not reached until the end of the year and during the first week of January a slight decrease only took place.

The decline of the epidemic in the Kelani-ganga basin has been less rapid. In the upper part of the river round Kitulgala, Deraniyagala, Karawanella, and Eheliyagoda the height of the epidemic was reached at the end of the year and the decline during the first week of January has been only about 10 per cent. while in the middle area round Avissawella, Waga, Hanwella, Padukka, and Kadawata, the number of patients attending remains stationary. The coastal area including the hospitals and dispensaries at Ragama, Hendala, Mutwal, Wellampitiya, Nugegoda, Pannipitiya, and Lunawa was invaded later and less severely than the upper and middle parts of the river and the height of the epidemic here was not reached until towards the end of the first week of January.

In the Central Province the area of the epidemic covers the Matale District in the north, and extends along the Mahaweli-ganga from Kotmale and Nawalapitiya in the south, to Teldeniya. The southern part of this area has not been so badly affected as the northern and the greatest number of cases was registered during the third week in December. There has been a considerable decrease in the Matale District and a slighter decrease elsewhere.

The basin of the Kalu-ganga has not been as badly affected as those of the Maha-oya and the Kelani-ganga and in the Ratnapura District there has been a steady decline in cases since the third week in December. In the middle area round Ingiriya, Horana, Pimbura, and Neboda the epidemic has not been severe and the number of cases remains fairly stationary. In the coastal area from Panadure to Beruwala the number of cases has been comparatively small, except at the Panadure hospital.

At the General Hospital, Colombo, since the middle of December the daily number of new malaria cases attending the Out-patients Department has averaged 45, and the daily average number of admissions of cases of malaria to the wards has been 47.

Treatment for malaria can now be obtained throughout the affected area where some 900 institutions including hospitals, dispensaries and new treatment centres are conducted by the Department of Medical and Sanitary Services. Over a large part of the area treatment centres are less than three miles apart.

The great majority of patients now attending hospitals and dispensaries were infected some weeks ago and are now suffering from relapses and the severe debility which in under-nourished persons so frequently follows malaria. The problem is a very difficult one to deal with since the average dispensary patient is apt to discontinue taking quinine treatment as soon as the fever has subsided.

Dispensaries and treatment centres are being supplied with a suitable tonic mixture for convalescent malaria patients, and in the worst areas under-nourished children are being provided with milk preparations from the dispensaries when they need it for medical reasons, but the provision of sufficient food to the people of the affected districts is essential for general recovery.

Colombo, January 15, 1935.

Press Communiqué issued by the Ministry of Health.

Except in a few places the incidence of malaria continues to fall slowly throughout the epidemic area.

The following table indicates the proportion of deaths from malaria to cases treated in hospitals :—

District.	October.		November.		December.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Colombo	81	1	197	4	1,549	41
Kalutara	35	1	43	1	748	27
Kandy	119	3	487	10	2,070	93
Matale	106	1	407	2	925	16
Nuwara Eliya	73	—	152	—	909	1
Hambantota	154	7	232	8	391	16
Kurunegala	397	16	1,213	22	1,596	64
Puttalam	61	—	155	—	447	5
Anuradhapura	151	2	431	4	568	6
Ratnapura	273	1	629	7	1,897	37
Kegalla	134	—	232	7	3,180	75
	1,584	32	4,178	65	14,480	381

The case mortality rate therefore was 2 per cent. for October, 1.3 per cent. for November and 2.6 per cent. for December.

The figures supplied by the Registrar-General for September, October, and November for the years 1930 to 1934 inclusive show that there was no abnormal increase in the number of deaths during September and October of 1934.

The following figures show the number of deaths registered in the month of November for the years 1930 to 1934 in certain districts, and the increase as shown is attributable to the start of the epidemic in those districts :—

	November.				
	1930.	1931.	1932.	1933.	1934.
Colombo	1,905	1,626	1,704	1,784	2,165
Kalutara	715	584	508	600	641
Kandy *	1,127	970	1,191	929	1,266
Matale	296	202	271	228	425
Nuwara Eliya	421	406	315	347	466
Hambantota	254	249	319	323	372
Kurunegala	780	593	911	763	1,394
Puttalam	273	242	251	232	344
Anuradnapura	212	200	281	232	382
Ratnapura	623	383	450	459	580
Kegalla	528	420	446	433	595
	7,134	5,875	6,647	6,330	8,630

The Department wishes to make it clear that the mosquito which is carrying malaria in Ceylon, viz., *Anopheles culicifacies* is not breeding in roof gutters, coconut shells, cans, &c., but in open pools of clear water, in river beds and in rock quarries. It may also be found in shallow wells, brick pits, borrow pits, saw pits, &c., where the water is clear and exposed to sunlight. It does not breed to any great extent in paddy fields or swamps.

Colombo, January, 19, 1935.

Press Communiqué issued by the Ministry of Health.

There is a definite drop in out-patient attendances in all the areas affected by the epidemic except in the upper parts of the Deduru-oya, Maha-oya, and Kelani-ganga basins, and even in these areas the number of new infections is considerably less than what it was three weeks ago. The majority of patients now seen at dispensaries are suffering from relapses, post-malarial debility, anaemia and, in children, oedema (swelling) of the face, hands, and feet, while a few cases of diarrhoea and dysentery resulting from malaria are still reporting for treatment. Cases of cerebral malaria, and of convulsions in children are now comparatively rare. Apart from the fall in numbers, therfore, milder forms of disease are being treated now, as compared with a month ago.

In the Western Province conditions show considerable improvement round about Gampaha and the reopening of the schools in this area is now justified.

In the worst parts of the Island, however, conditions still remain bad in spite of the improvements mentioned above, and there can as yet be no slackening of the efforts to deal with the effects of the epidemic.

Headmen, Sanitary Inspectors and relief workers in the villages are sending ill-nourished and debilitated patients in large numbers for admission to hospitals and most of the hospitals in the bad areas are full and the temporary wards which have recently been provided are proving of great use.

In many places the convalescent homes and temporary hospitals which voluntary efforts have established are also proving of great benefit and are supplementing the work of Government hospitals. Some of these temporary hospitals and convalescent homes are being conducted on excellent lines, but in others, which have been started by persons without experience and without technical advice, there is serious over-crowding, deficient sanitation and lack of proper facilities for care of patients which may result in the spread of infectious diseases, such as ophthalmia and dysentery. Government Agents and the Department have therefore been obliged to lay down certain minimum standards if Government assistance is to be given to such institutions.

Recently Medical Officers in out-stations have reported that villagers who have taken Walhabarala as a cure for malaria frequently suffer from colic and severe enteritis and that among children deaths have occurred following its use.

At the General Hospital, Colombo, the total number of cases admitted to the wards during the two weeks ended January 19, 1935, was 1,497. Of these 575 cases were cases of malaria. The total number of deaths in the hospital during this period was 178. Of these 31 were due to malaria. The average daily number of new cases treated at the Out-patients' Department was 193, the daily average of malaria cases being 75.

Colombo, January 24, 1935.

Press Communiqué issued by the Ministry of Health.

Hospital figures for treatment of malaria given in the Press Communique dated January 19, 1935, for hospitals in Kandy and Nuwara Eliya Districts should read as follows:—

	October.		November.		December.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Kandy District	124	3	505	10	2,706	93
Nuwara Eliya District	68	—	134	—	273	1

The error was due to the inclusion of the Nawalapitiya Hospital figures in the Nuwara Eliya instead of the Kandy District.

Colombo, January 26, 1935.

Press Communiqué issued by the Ministry of Health.

The decline of dispensary figures in almost all areas continues and everywhere the proportion of new infections and re-infections to total cases is small. In the coastal area from Chilaw to Kalutara epidemic conditions no longer exist. But there are enormous numbers of persons still suffering from relapses and the conditions of debility and anaemia which invariably occur in an agricultural population after the acute phase of a severe malaria epidemic, and the number of admissions to hospitals therefore continues to increase. Cases of a dysenteric nature are now becoming uncommon.

Owing to the increase of such cases, which require indoor treatment three temporary wards have recently been opened at the Kurunegala Hospital, two wards are being erected at Kegalla and one for 100 patients is nearing completion at Kandy. A number of temporary hospitals are also being established by the Medical Department to supplement the work of the main hospitals.

Canalization and oiling have been carried out on a stretch of 30 miles of the Maha-oya and some of its tributaries from about Mawanella to Mirigama. This measure should be of local benefit, but it cannot be relied on to eliminate malaria.

For the information of the press and the public a statement of the admission and out-patient treatment at the General Hospital, Colombo, for the previous day, giving both malaria cases and cases of other diseases, is posted daily on the Press Notice Board at the Secretariat.

Colombo, January 31, 1935.

Press Communiqué issued by the Ministry of Health.

In order to deal with the large number of cases of debility and complications following malaria, in addition to the temporary wards mentioned last week as opened at the hospitals at Kegalla and Kurunegala, temporary wards are now opened at Kandy and Teldeniya Hospitals and another is being erected at Gampola.

Government temporary hospitals have been established, or are being established, at Hanwella, Kirindiwela and Biyagama in the Western Province, at Katugastota in the Central Province, at Polgahawela, Narammala, Weuda, Wariyapola, and Hettipola in the North-Western Province, and at Mawanella, Rambukkana, Mattamagoda, and Dedigama in Province of Sabaragamuwa. Other hospitals and convalescent homes are under consideration.

In addition, 29 temporary hospitals and convalescent homes which have been started by volunteer workers are receiving Government assistance. These are at Anuragoda, Talagalla, and Maradana in the Western Province, at Galagedera, Hataraliyadde, Eramuduliyadde, Minigomuwa, Idamagama, Dellewe, Akuramboda, Nugatenne, Battuwatte, Yalegoda, Nawalapitiya, Gampola, Kandy Barracks, Matale, and Teldeniya in the Central Province; at Bopitiya, Handalankawa, Delwita, Gonigoda, Dandegamuwa, Wanduragala, and Potuhera in the North-Western Province, and at Kegalla, Deraniyagala, Kehelwatta, and Ganetenne in the Province of Sabaragamuwa.

A careful watch is being kept on the parts of the rivers in the epidemic area where breeding of *Anopheles culicifacies* is likely to take place. The following are the chief points at which investigations are being made :—

Maha-oya.

Hunumulla
Giriulla and Alawwa
Ambepussa
Mirigama and Attanagalla
Polgahawela
Kegalla
Aranayake

Kelani-ganga.

Sitawaka
Pugoda
Hanwella
Avissawella
Ruwanwella
Kitulgala
Dehiowita
Ratnapura

Deduru-oya.

Nikaweratiy
Mahagaboda
Kirindigala
Ganewewa
Naramankotuwa
Welangolla
Nammadawewa
Hulugalla

Deduru-oya and Kospotu-oya.

Batalagoda
Delwita
Kospotu-oya
Oya near Ganewatta

Mahaweli-ganga.

Peradeniya
Getambe
Katugastota
Teldeniya
Haragama
Kundasale
Ambatenna
Wattegama
Mailapitiya

As soon as *culicifacies* mosquitoes are found breeding in any place, oiling will be done or the pool will be drained. At present the slight rainfall that took place has made the Maha-oya, Kelani-ganga and Mahaweli-ganga unsuitable for the breeding of malaria carrying mosquitoes. A report has just been received that *Anopheles culicifacies* are breeding in the Deduru-oya near Delwita and immediate action is being taken.

Arrangements are being made for anti-malaria relief works to be done by some of those persons who, though they need relief, are capable of working. These works will be done around the more populous vllages. The following areas have so far been selected:—

Villages around the Attanagal-oya and Pugoda in the Western Province.

An area of one mile round the following centres in the North-Western Province :—Polgahawela, Potuhera; Kuliyapitiya, Alawwa, Giriulla, and Boyawalana.

An area of one mile round the following centres in the Kegalla District:—Kegalla, Rambukkana, Mawanella, Aranayake, Alpitiya, and Ganetenne.

Some other areas have yet to be selected.

Colombo, February 6, 1935.

Press Communiqué issued by the Ministry of Health.

The general improvement throughout the epidemic area continues. Epidemic conditions no longer exist in the Ratnapura District and the Raigam Korale of the Western Province, and the improvement during the past two weeks in the Matale District has been very great. The Kegalla District, the southern part of the Kurunegala District, the Tumpane Division in the Central Province and the Siyane Korale East in the Western Province continue to be the areas where the greatest amount of medical attention is still required. The Medical Department is therefore opening further temporary wards at the Kurunegala Hospital, and has already established temporary hospitals at Polgahawela, Narammala, Hettipola, Mawanella, Rambukkana, Mattamagoda, and Dedigama. These temporary hospitals each accomodate from fifty to eighty patients, and five more are about to be opened during the present week at Weuda, Wariyapola, Hanwella, Kirindiwela, and Biyagama.

In most districts schools have now been re-opened and the attendance is good particularly where a free mid-day meal is given to the children. Even in the worst districts it is desirable that an effort should be made to reopen the schools and to provide the children with quinine and a meal.

The reports from the Entomological Laboratory indicate that few infected mosquitoes are now being found, but the lack of rain since the end of January has made it necessary to recommence anti-larval measures on certain of the rivers where *Anopheles* breeding is found to be taking place. At the present time such measures as oiling and minor drainage are being undertaken on the Deduru-oya near Chilaw, the Kospotu-oya, the tributaries of the Maha-oya, the Attanagala-oya, and the Pindeni-oya, while work on the Mahaweli-ganga near Katugastota is about to start. Other rivers and their tributaries are under observation; but as *Anopheles* breeding is not taking place in them anti-larval measures are not necessary at present.

Colombo, February 11, 1935.

Press Communiqué issued by the Ministry of Health.

A slow improvement in the conditions in the epidemic area continues. It has to be realized that in the worst parts of the area, *e.g.*, the Kurunegala and Kegalla Districts most of the patients were infected and re-infected time after time during the height of the epidemic in December and early January. Further the bulk of the cases are suffering from thet so-called "benign" type of malaria which gives a much higher relapse rate than the "malignant" type. Relapses, therefore, are likely to take place in a very large number of patients for many months to come, and continued and careful medical treatment and sufficient food for these cases still remain very necessary.

During the past fortnight the Department of Medical and Sanitary Services has opened twelve temporary hospitals with accommodation for about 900 patients, and is arranging to take over two hospitals which were opened by voluntary effort at Mirigama and Deraniyagala within the next few days.

Since the communique of the 11th February, 1935, oiling works have been undertaken to control breedings of *Anopheles culicifacies* in the following additional rivers :—

Talatu-oya—tributary of the Mahaweli-ganga, three miles from Kandy.
Kuda-oya tributary of the Maha-oya, near Kurunegala.
Delwita-oya—tributary of the Deduru-oya.
Sitawaka-oya—branch of the Kelani-ganga.
Tributaries of the Deduru-oya near Nikaweratiya.

Colombo, February 15, 1935.

Press Communiqué issued by the Ministry of Health.

The decline in the number of cases requiring out-door treatment for malaria continues throughout the epidemic area. The numbers admitted to hospitals continue to increase, complications such as severe anaemia, colitis, enteritis, and dysentery being frequent. The temporary hospitals at Mirigama and Deraniyagala have now been taken over by the Department of Medical and Sanitary Services, and steps have been taken to establish temporary hospitals at Tiragama, Wellawa, and Buluwella. There are now therefore 8 Government temporary hospitals in the Kurunegala District, 5 in the Kegalla District and 4 in the Western Province in addition to extra temporary wards at the permanent hospitals. Besides this, 28 temporary hospitals and convalescent homes run by voluntary bodies are receiving Government assistance.

Further streams on which anti-larval measures are being taken are the Maguru, Reddegoda, and Kimbulwana Oyas, tributaries of the Deduru-oya, the Ping, Pussella, and Kiullinda oyas, tributaries of the Mahaweli-ganga, the Nelundeni, and Kegalla-oyas as well as other tributaries of the Maha-oya and also certain sections of the main rivers themselves. The recent heavy rain in the valleys of the Kelani-ganga and Kalu-ganga has stopped Anopheline breeding in those rivers.

There seems to be some misunderstanding as to the reasons why some rivers are "oiled", and some not. "Oiling" large areas is an expensive operation and is quite useless when done in places where Anopheline mosquitoes are not breeding. It is therefore only being done in places where Anopheline mosquitoes are breeding, while other places are kept under observation so that control work can be undertaken as soon as breeding starts. It should further be pointed out that "oiling" is not in most places the ideal method of control. Canalization or filling, which are more permanent and effective, are done where possible and oiling only where unavoidable. Oiling requires trained staff and a number of gangs have now been trained for this work.

Colombo, February 21, 1935.

Press Communiqué issued by the Ministry of Health.

Anti-larval measures are being taken in the following places where conditions are favourable for Anopheline breeding:—

Maha-oya.—

Main River—from one mile above Aranayake to one mile below Giriulla.
Branches:

- Raddala-oya—Raddala to Hiriwadunne.
  - Forest Hill to Molagoda-ela.
- Kegalla-oya—Marapone-oya to Alawwa Bridge.
- Nelundeniya-oya—Nelundeniya to Kahambiliyawela.
- Kuda-oya (1) and Dowewa-oya—Talleyadda to Maha-oya junction.
  - Dowewa-oya branch to Ambepussa Rest House.
- Kuda-oya (2)—Dambukanda and Tambugala Branches to Koswatta via Mirigama.
  - Mirigama Rest House Branch.
- Polgahawela-oya—Godawala to Sunnymead.
- Rambukkana—Around the Town.

Ja-ela and Branches.—

- Branch Attanagalla-oya—Wanduramulla to 1 mile below Gampaha.
- Diya-ela Oya—Veyangoda to Minuwangoda Junction.

Mahaweli-ganga.—

Main River—Haragama Section, Katugastota Town Section.
Branches:

- Ping-oya—Nive Ella School to Katugastota Post Office.
- Hannan-oya—Botota to Ambatenne Junction.
- Rawan-oya—Wattegama to Mahaweli-ganga junction.
- Talatu-oya—Uduwila Branch to Devale Post Office.
- Kiulinda-oya—Hanguranketa Road Bridge to Upper Hanguranketa Road.
- Nanu-oya—Alakole Anga to Old Peradeniya Station.

Deduru-oya.—

- Nikaweratiya Bridge to Walpola.
- Amunagama.
- Delwita-oya.

Work has been momentarily stopped in the Kelani-ganga owing to rain.

Colombo, March 1, 1935.

Press Communiqué issued by the Ministry of Health.

There has been little change in the malaria situation during the past week. The slow but steady improvement continues. The weekly number of out-patient attendances in the epidemic area has now fallen to about half of that in the third week in December. Pressure on the hospital accommodation is becoming less acute. There is a definite decline in the number of deaths occurring in the Kegalla and Kurunegala Districts. The daily consumption of quinine, which at the end of December and beginning of January was 320 lb., has now fallen to 190 lb.

The outlook, however, is uncertain. Almost no rain has fallen during the past week and all the rivers in the epidemic area are affording suitable conditions for anopheline breeding. While vigorous anti-larval measures are being carried out, it is not anticipated, in view of the thousands of miles of rivers and streams in the affected area, that anything approaching complete protection will be achieved.

Government is now running 20 temporary hospitals and assisting 43 voluntary hospitals and convalescent homes excluding the excellent convalescent homes at Maradana and Talagolla which have since been closed as they were no longer needed.

Colombo, March 8, 1935.

Press Communiqué issued by the Ministry of Health.

The malaria situation continues to improve. The number of out-patient attendances is slightly decreasing, and although the number of admissions to hospitals and temporary hospitals remains high a large proportion of these cases are not malarial patients but are suffering from debility. The new temporary hospital Nedalegama has now been completed.

Anti-mosquito works as relief measures have been undertaken or are being undertaken in the villages around Kegalla, Alpitiya, Aranayaka, Rambukkana, Mawanella, Ganetenne, Hettimulla, Kehelwatta, and Undugoda in the Kegalla District, in the villages around Boyawalana, Kuliyapitiya, and Giriulla in the Kurunegala District, in the villages around Galagedara, Nawayalatenna, Wattegama, Teldeniya, Nawalapitiya, Modagama, Kahatapitiya, and Ulapane in the Kandy District, in the villages around Ukuwela, Aluwihare, Mahawela, Kawdupelella, and Rattotta in the Matale District and in the villages around Hunupola, Attanagalla, Welagedara, and the Attanagalu-oya in the Gampaha area of the Western Province. This is in addition to the anti-larval work being done by the anti-malaria campaign of the Department of Medical and Sanitary Services in the rivers and their tributaries in the epidemic area.

Colombo, March 15, 1935.

Press Communiqué issued by the Ministry of Health.

The improvement in the malaria situation was slightly more rapid during the past week than it had been for some time. Only at Dandagamuwa has there been an appreciable increase in the number of out-patient attendances. The congestion in the Government hospitals in the epidemic area is diminishing and several convalescent homes, which during the past two months have greatly relieved the pressure in the hospitals, are now about to close. The third and fourth weeks of March were considered a critical period from the point of view of a recrudescence of the epidemic, but there has been no evidence of recrudescence anywhere yet, and the danger of any generalized recrudescence is now almost over.

The death rate in the epidemic area which started to fall at the end of January is now declining rapidly.

The anti-mosquito works undertaken as a relief measure in village areas in the Kegalla District have been placed in charge of a special officer who has organized the work according to a uniform system in Beligal korale and the Three Korales and much useful work has already been carried out. The anti-larval measures on rivers and streams were continued, but the heavy rain in the Maha-oya, Kelani-ganga, and Kalu-ganga areas on the 18th and 19th March has stopped anopheles breeding and removed the need for oiling measures for the time being.

Colombo, March 22, 1935.

Press Communiqué issued by the Ministry of Health.

The malaria situation continues to improve everywhere, and the slightly increased rapidity in the improvement mentioned in last week's communique has been maintained. Seven temporary hospitals and convalescent homes conducted by voluntary bodies with Government assistance have been closed and some of the Government temporary hospitals have now many empty beds.

The recent heavy rains which have fallen over the river basins and the river catchment areas of the affected districts have rendered conditions unsuitable for prolific mosquito breeding.

The rain and variations in temperature are, however, likely to cause relapses and will perhaps lead to an increase in the number of cases of pneumonia.

In view of the steady improvement in conditions and the improbability of any recrudescence, no further weekly communiques will be issued unless there is a change in the situation.

Colombo, March 29, 1935.

Press Communiqué issued by the Ministry of Health.

In view of the increase in the number of malaria patients which occurred in certain areas during the week ending April 13 the following review of the malaria situation is given:

Throughout the Kurunegala District conditions continue to improve and there is no indication of any set back.

The whole of the coastal region from Chilaw to Beruwala inclusive shows improvement and in most parts of this region conditions are approaching normal again.

In parts of the Kandy, Kegalla, Ratnapura, and Colombo Districts there were, however, sharp rises in the dispensary attendance figures. These figures give the earliest and most sensitive indication of variations in the amount of malaria of an area. The following list shows the centres at which definite increases were recorded:—

	Hospital or Dispensary.	Outdoor attendance for week ending April 6.	April 13.
Kandy District	Gampola	1,000	1,866
	Peradeniya	1,129	1,434
	Katugastota	2,554	2,913
	Kandy	1,922	2,385
	Kadugannawa	1,389	1,782
	Nawalaptiya	1,609	2,146
Kegalla District	Mawanella	1,796	2,394
	Aranayake	1,698	2,623
	Pindeniya	1,370	1,811
	Karawanella	3,131	3,366
	Eheliyagoda	1,387	2,117
Ratnapura District	Kuruwita	1,379	1,868
	Ellagawa	668	990
	Pelmadulla	807	922
Colombo District	Padukka	1,547	1,986
	Hanwella	2,272	2,676
	Waga	992	1,358

It is not unlikely that further increases will occur during the next few weeks since it is usual at this period of the year for localized outbreaks to take place in the wet zone. General recrudescence of the epidemic is, however, not to be anticipated.

Colombo, April 17, 1935.

Press Communiqué issued by the Ministry of Health.

1. The malaria situation during the week ending April 20, has been less favourable as the result of localized outbreaks.

2. In the Kurunegala District there were slight but significant rises in the hospital and dispensary attendance figures at Kurunegala, Mawatagama, Wariyapola, Maho, Nikaweratiya, Polgahawela, Giriulla, and Dandagamuwa.

3. Throughout the Kegalla District the number of persons seeking treatment for malaria increased and at Mawanella, Undugoda, Nelundeniya, Rambukkana, and Warakapola the rise in out-door attendance figures was large, while at Aranayaka and Pindeniya the number of out-patients exceeded those at the end of December.

4. In the affected parts of the Kandy District there was a moderate increase in the attendance figures which was the greatest at Nawalapitiya.

5. The Kandy Civil Hospital had nearly 700 patients in its wards, but the congestion was relieved to some extent by the re-opening of the Kandy Convalescent Home on April 22.

6. At Matale 50 per cent. more out-patients attended than during the previous week and several of the dispensaries in the district were busier.

7. In the Colombo District malaria cases have increased considerably during the past week round Hanwella and there have been smaller increases at Padukka, Avissawella, Gampaha, Veyangoda, Minuwangoda, and Negombo.

8. No significant increase occurred in the Kalutara District except at the village of Matugama where during the past four weeks there has been a sharp outbreak of malaria.

9. In the Ratnapura District except at Nivitigala, Kuruwita and Ellagawa there has been no great rise in the malaria incidence.

10. Dispensary attendance figures for the places at which rises have been noted for the week ending April 13th and the week ending April 20th are as follows :—

	Hospital or Dispensary	Out-door Attendance for Week ending April 13th.	April 20th.
Kandy District	Gampola	1,866	2,010
	Peradeniya	1,434	1,758
	Katugastota	2,913	2,902
	Kandy	2,385	2,595
	Kadugannawa	1,782	2,197
	Nawalapitiya	2,146	2,726
Kegalla District	Mawanella	2,394	3,396
	Aranayake	2,623	2,936
	Pindeniya	1,811	2,193
	Karawanella	3,366	3,723
	Eheliyagoda	2,117	2,555
Ratnapura District	Kuruwita	1,868	2,213
	Ellagawa	990	1,202
	Nivitigala	673	875
Colombo District	Avissawella	3,109	3,375
	Negombo	1,140	1,355
	Halpe	1,979	3,046
	Hanwella	2,676	3,315
	Padukka	1,986	2,219
	Waga	1,358	1,889
	Veyangoda	2,036	2,370
Kurunegala District	Kurunegala	1,322	1,598
	Dambadeniya	896	1,192
	Dandagamuwa	2,820	3,234
	Polgahawela	1,205	1,693
	Hettipola	821	1,123

11. The increases now taking place are generally on a very much smaller scale than those of November and December last year and the disease is usually a milder type. Cerebral cases and convulsions have been rare.

12. Hospital and dispensary staffs are being considerably strengthened wherever the volume of work has increased. Special officers are being detailed to visit badly affected villages. Almost all the Government temporary hospitals are still being kept open, although many of them are only partially filled.

13. The recently received supplies of atebrin mussonate are being tested in all the larger hospitals in the area and careful records of the results are being kept.

Colombo, April 24, 1935.

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